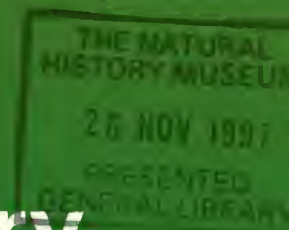
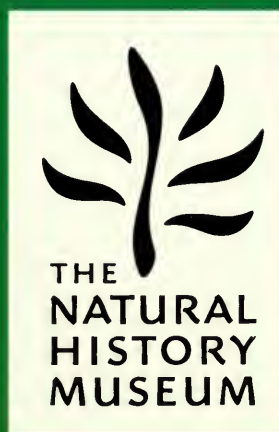


# Bulletin of The Natural History Museum



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# Systematics of *Pogostemon* (Labiatae)

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**SYNOPSIS.** A taxonomic review of the genus *Pogostemon* Desf. and related genera has been undertaken. About 80–90 species of *Pogostemon* sensu lato are currently recognized, 79 of which have been examined for this review. A new infrageneric classification is presented. The character variation in the genus is described in full with the inclusion of many characters not used before and a reassessment of previously used characters. Nutlet shape and surface morphology and calyx shape and the distribution of hairs on the calyx is described systematically for the first time. Taxonomically important characters come from all parts of the plant but inflorescence type and calyx morphology and hairiness have proved most useful in establishing a clearly defined infrageneric classification. Keys to infrageneric taxa and species are provided and a systematic account is given of 79 species. Three new species and one new variety are described, *P. barbatus*, *P. ciliatus*, *P. elatispicatus*, and *P. erectus* var. *diplobatus*.

## INTRODUCTION

*Pogostemon* Desf. is a well defined genus of moderate size. The presence of exserted stamens bearing moniliform hairs marks it out from other Labiatae. It is variable with much variation concentrated in small flowered aquatic and marshland plants and larger flowered terrestrial herbs or subshrubs. These two kinds of variants have been recognized as separate genera, subgenera or sections, for example *Dysophylla* Blume for the former and *Pogostemon* sensu stricto for the latter, but they are linked by species intermediate in various characters.

*Pogostemon* sensu stricto includes the most important species used as a source of patchouli oil. Patchouli oil, a strong scented essential volatile oil, is extracted from the dried tops. It is used in incense, perfumes, and cosmetics. Almost all of the patchouli species have a well-branched inflorescence. Cultivated species are marked by their lack of both floral and vegetative diversity. However several species, somewhat obscurely delimited, have been described.

The recognition of species is made difficult by the introduction of patchouli plants to new areas and by the development of new cultivars in different areas. Cultivated species have become naturalized so that some are very widespread in nature. *Pogostemon plectranthoides* Desf. is widespread throughout India but especially in the north. *Pogostemon heyneanus* Benth. is found from Sri Lanka and southern India through mainland Malaysia and Sumatra to Java. *Pogostemon cablin* (Blanco) Benth. is the most scattered, with populations on Fiji, in the Philippines, Mauritius, as well as Sumatra and Thailand. There are a number of geographically restricted similar taxa. *Pogostemon benghalensis* (Burm.f.) Kuntze which is very like *P. plectranthoides* but has smaller flowers, is concentrated in the more temperate conditions of northern India, Nepal, China, and northern Thailand, and *P. glaber* Benth., which is distinct in leaf shape and pattern of hairiness, is found over a similar geographical range. A more in depth examination of the population and geographical variation of these species may result in the amalgamation of several species. Without a population study and without cultivation experiments the currently recognized species have been



maintained as operational taxonomic units as a first step in a revision of the infrageneric classification.

Non-patchouli species of *Pogostemon* sensu stricto are more diverse and better delineated. For example there is *P. litiginosus* Doan with a two-lipped calyx. Species are generally narrowly endemic to areas such as Sri Lanka or southern India, the eastern Himalayas, Yunnan, Java, Borneo or southern Africa.

*Dysophylla* includes all the small flowered species which tend to have flowers crowded into dense verticillasters. Many species have a weak stem, probably because they are aquatic or marshland inhabitants. The calyx is small, translucent, and infundibular with a wide diameter. Most species have verticillate, linear to linear-lanceolate leaves. However, there are a number of species which combine the character states of *Pogostemon* sensu stricto and *Dysophylla*, so that the boundary between these taxa has not always been stable, with different workers putting the same species into one or other group or not recognising the groups at all. This is described in greater detail below.

The study reported here is a re-examination of the variation of *Pogostemon* sensu lato leading to the erection of a new infrageneric classification which is more natural and which may be used as the basis for future studies at lower taxonomic rank. A cladistic and phenetic analysis of characters has aided the resolution of new infrageneric taxa but this has not been used directly because certain characters, thought to be more constant and reliable, have been weighted as more important in the classification, but all characters were weighted equally in the cladistic and phenetic analysis. The cladistic and phenetic analysis will be reported elsewhere.

## History of the classification of *Pogostemon*

*Pogostemon* was described by Desfontaines (1815) as a distinct genus of Labiatae because of its hairy stamens: *pogon* is Greek for beard and *pogonostemon* means 'with bearded stamen' (Stearn, 1992). The type species for the genus is *P. plectranthoides* Desf. Desfontaines placed his new genus near *Hyssopus* L. *Dysophylla* Blume was described as a distinct genus, related to *Pogostemon* by having bearded stamens (Blume, 1826). *Dysophylla* had been previously recognized as distinct by some authors under different names. Hermann (1717) gave the polynomial *Veronica hirsuta latifolia Zeylanica aquatica* to a species of *Dysophylla*. Linnaeus (1747) listed a genus *Alopeuro-veronica*, a name he later cited as a synonym of *Mentha auricularia* (Linnaeus, 1767). The name *Majorana foetida* was given as another synonym, a species described by Rumphius (1750) as *Majana foetida*. He described it as having no close affinity to other species of *Mentha*. Blume (1826) cited Rumphius' illustration when he recognized *Dysophylla* as a distinct genus based on *Dysophylla auricularia* (L.) Blume (= *Mentha auricularia* L.). Although he placed *Dysophylla* next to *Mentha* L. he considered it different from *Mentha* by having closure of the fruiting calyx, fleshy swelling of the disc, and bearded stamens. At about the same time Blume (1826) published a species from Java he called *P. menthoides* Blume. Later, however, Benth (1829) questioned the placing of *P. menthoides* in the genus *Pogostemon* because it had naked filaments.

Benth (1829, 1830, 1832–1836) also widened the concept of *Dysophylla* by including species described as *Mentha* by Loureiro (1790) and Roxburgh (1814, 1832). Benth (1830) divided *Dysophylla* into two groups on the basis of phyllotaxy, one group with opposite leaves and the other verticillate leaves. In *Labiatarum genera et species* Benth (1832) formally recognized these groups as section *Oppositifoliae* and section *Verticillatae*. Section *Oppositifoliae*, which agreed with Blume's original description of

*Dysophylla* included three species: *D. auricularia*, *D. myosuroides* Benth., and *D. strigosa* Benth. In the same work Benth (1832–1836) divided the genus *Pogostemon* into two sections, the *Paniculatae* and the *Racemosae* on the basis of the type of inflorescence.

Benth's splitting of *Dysophylla* and *Pogostemon* was taken further, first by Rafinesque-Schmaltz (1847) and later by Briquet (1897). Rafinesque-Schmaltz (1847) effectively raised *Dysophylla* section *Verticillatae* to generic rank by publishing a new genus *Eusteralis* Raf., which included *Mentha pumila* Graham and *M. verticillata* Roxb. Briquet (1897) subdivided *Dysophylla* and *Pogostemon* into sections and subsections, as follows:

### Genus *Dysophylla*

Sect. I. *Rhabdocalicinae* Briq. (Calyx tube cylindrical and rounded or very indistinct, pentagonal)

#### §1. *Oppositifoliae* Benth.

A. Perennial species

B. Annual species

#### §2. *Verticillatae* Benth.

Sect. II. *Goniocalicinae* Briq. (Calyx tube prominently five-angled)

### Genus *Pogostemon*

#### §1. Section *Racemosa* Benth.

A. *Glabriuscula* Briq. (Naked filaments)

B. *Barbata* Briq. (Hairy filaments)

#### §2. Section *Paniculata* Benth.

A. Interrupted verticils

B. Continuous verticils

Kudo (1927) treated *Dysophylla* and *Pogostemon* as distinct genera under subtribe *Pogostemoninae*. He divided *Dysophylla* into two sections:

Section *Eudysophylla* – stem indumentum tomentose to hirsute and leaves opposite, broad, ovate-lanceolate, margin serrulate (includes only *D. auricularia*).

Section *Chotekia* – stem glabrous to pubescent and leaves verticillate, narrow, linear to linear-lanceolate with an entire margin.

Four species which belong to Benth's *Dysophylla* section *Oppositifoliae* (*D. auricularia*, *D. myosuroides*, *D. rugosa* Hook.f. and *D. salicifolia* Dalzell ex Hook.f.) were transferred to *Pogostemon* on the basis of having opposite, broad and petiolate leaves, presence of crystals in the calyx, and absence of an aerenchyma tissue in the stem (El-Gazzar & Watson, 1967). Wu & Li (1975) also transferred *D. auricularia* and *D. falcata* C.Y. Wu to *Pogostemon* but without mentioning any reason for doing so. The removal of *D. auricularia*, in particular, posed a nomenclatural problem because it is the type species of *Dysophylla*. A solution to this problem was put forward by Panigrahi (1976) and Bakhuizen van den Brink & van Steenis (1963), who suggested the generic name *Eusteralis* Raf. for the remaining species of *Dysophylla*, those in section *Verticillatae*. Keng (1978) also placed *Dysophylla* section *Verticillatae* in *Pogostemon* section *Eusteralis* Raf. However, Panigrahi (1984) referring to Article 22.4 (I.C.B.N. 78) mentioned that *Pogostemon* section *Verticillatae* Benth. has priority over *Pogostemon* section *Eusteralis* (Raf.) H. Keng.

Several authors found it difficult to distinguish *Dysophylla* from *Pogostemon* (Hassk  rl, 1842; Miquel, 1859; Kuntze, 1891; Keng, 1978). Press (1982) criticized Briquet's division of *Pogostemon* and *Dysophylla* because of the obscurity of the characters used. Press' (1982) phenetic analysis of characters found no evidence for the grouping of taxa as proposed in Briquet's classification.

## MATERIALS AND METHODS

All the specimens listed in the systematic account were examined and used for data analysis. Some other specimens were rejected because they were incomplete at the correct state of development or had no information about their geographical origin. As a result the following possibly distinct species were not available: *Pogostemon brevicorollus* Y.Z. Sun, *P. reticulatus* Merr., *P. falcatus* (C.Y. Wu) C.Y. Wu & H.W. Li, *P. szemacensis* (C.Y. Wu & S.J. Hsuan) Press, and *P. tsiangii* (Y.Z. Sun) Press. Herbarium material of *Pogostemon* and other genera has been obtained from the herbaria of The Natural History Museum (BM), the Royal Botanic Gardens, Kew (K), and the Royal Botanical Garden Edinburgh (E). More than half of the total number of species under investigation have been reported from India. A field excursion to this country was undertaken in 1991. The following herbaria of the Botanical Survey of India were visited: Poona (BSI), Calcutta (CAL), Coimbatore (MH), Dhera Dune (BSD), and Rabinath Herbarium, St. Joseph College (RHT).

Wherever doubt existed regarding identification, type material and the type description have been examined. In eighty-five per cent of species it was possible to study at least one type specimen. A few species have been observed in their natural habitat in India. These include: *Pogostemon paniculatus* (Willd.) Benth. (not flowering), *P. purpurascens* Dalzell (not flowering), *P. quadrifolius* (Benth.) Kuntze, *P. heyneanus* Benth. (cultivated), *P. auricularius* (L.) Hassk., and *P. plectranthoides* Desf. (not flowering). Cultivated material of *P. plectranthoides* and *P. quadrifolius* was available and used to check that dried material accurately represented the living state.

Descriptions of species in the various Floras of the different regions were also examined. However, it has been found that many floristic accounts simply repeat descriptions of earlier workers, even where these are erroneous. Some specimens have been regularly misidentified because of the close similarity of a number of species. For example, the names *Pogostemon brachystachyus* Benth., *P. fraternus* Miq., and *P. macgregorii* W.W. Sm. have often been wrongly applied by earlier workers.

Mature plant specimens were selected for examination. The maximum size of each part of the plant were recorded. However, for many tall plants, the herbarium sheets have been prepared from only the upper parts of the plant with the inflorescence. Much longer leaves are present at the basal part of the plant. For example, in *Pogostemon plectranthoides* older leaves towards the basal part of the stem of about 23 cm long have been observed in living material, whereas the maximum size in herbarium specimens is about 14 cm.

The small size of the flowers posed many difficulties in carrying out a detailed study of the calyx and corolla directly from herbarium material. Flowers ranged from 1.5–4 mm. Permanent slides of the corollas and calyces, and where possible bracts, were made in order to record some of the unique characters which have never previously been fully described. Dried flowers, obtained from herbarium specimens, were boiled in water. Then the soaked corollas and calyces were dissected to expose their inner sides and mounted on slides with DPX mountant without any other treatment.

Normally 5–10 calyces and corollas were examined from each specimen, but, if there was any doubt or complication in scoring the required information, then the number of samples were increased. Nutlets were obtained from fruiting calyces. A scanning electron microscope (JEOL JSM 35CF) study was carried out on nutlet morphology and hairs at the middle and towards the lower part of the filaments. Samples were collected from herbarium sheets, mounted on stubs, and coated with gold by a sputter coater (EMITECH K550)

for 8–12 minutes. Almost all of the samples examined were air dried, but a comparison was made with fresh material, dried using a critical point drier (POLARON) to confirm characterization.

Data were subjected to cladistic analysis and phenetic analysis (Bhatti, 1995). Details and a comparison of the results of different cladistic and phenetic analysis will be reported elsewhere.

## RESULTS

For this study most species currently recognized in floristic works were maintained. Three new species are described below.

Geographical coverage was patchy. In particular there were few specimens from China and parts of southeastern Asia. Even in the Indian sub-continent, from where the majority of samples originated, it was clear that some geographical areas were much better represented than others. This may reflect in part the greater floristic diversity of parts of Assam and Keralia, but also probably reflects the historical incidence of sampling by individual collectors. The lack of a good sample of the variation of many species made it impossible at this stage to consider redefining the limits of most species. Instead we have concentrated on describing reliable characters for identification in the systematic account below. Nonetheless it was clear that some species are more distinct than others.

An infrageneric classification is proposed which resurrects, at least in part, that of previous workers. However, the inclusion of new characters, especially those from a detailed study of floral morphology, has allowed subgenera, sections, and subsections to be defined more clearly. The order of taxa in the systematic treatment is similar to that in a computed consensus tree obtained by cladistic analysis but the arrangement is not identical because in the classification the characters have been weighted by their ease of use and reliability. Complex character states and combinations of unitary character states which may be less likely to exhibit parallel or convergent evolution have been used to define groups at the higher ranks in the hierarchy and more simple unitary characters at lower ranks. There is a shortage of 'good' characters and in some cases a polythetic approach has been adopted as a more reliable guide to forming a natural group. In these cases rank has been established with reference to the magnitude of the taxonomic discontinuity between the groups and the size of the group, validated where possible with reference to geographical and ecological data. Some groups are linked by intermediate species but these have been allocated to the group which contains their closest relative.

### Summary of infrageneric classification

Genus *Pogostemon* Desf.

I. Subgenus *Pogostemon* sensu Bhatti & Ingr.

II. Subgenus *Allopogostemon* Bhatti & Ingr., *subgen. nov.*

a. Section *Racemosus* (Benth.) Bhatti & Ingr., *stat. nov.*

i. Subsection *Racemosus*

ii. Subsection *Glabriusculus* (Briq.) Bhatti & Ingr., *stat. nov.*

b. Section *Zygocalyx* Bhatti & Ingr., *sect. nov.*

III. Subgenus *Dysophyllus* (Blume) Bhatti & Ingr., *comb. et stat. nov.*

a. Section *Dysophyllus*

b. Section *Verticillatus* (Benth.) Bhatti & Ingr., *comb. nov.*

Names of infrageneric taxa used in the text below are sensu Bhatti & Ingr., except where stated otherwise.

The shrubby patchouli species which have been placed here in subgenus *Pogostemon* include several rather poorly defined taxa



around *Pogostemon benghalensis*, *P. plectranthoides*, *P. cablin*, and *P. heyneanus*. Patterns of variation are complicated by the cultivation of variants which are maintained vegetatively and rarely flower and their introduction into areas outside the native distribution of the species. New data are required before they may be considered as variants of one or more polymorphic species. We have hesitated to submerge all species of subgenus *Pogostemon* into a single polymorphic species *P. plectranthoides* sensu lato.

In subgenus *Dysophylla* a similar population based study is needed to evaluate the relationship of narrowly restricted endemics like *Pogostemon erectus* Kuntze, *P. koehneanus* (Muschl.) Press, and *P. andersonii* (Prain) Press to geographically widespread taxa like *P. stellatus* (Lour.) Kuntze, *P. crassicaulis* (Benth.) Press, and *P. cruciatus* (Benth.) Kuntze.

A newly defined group is *Pogostemon* subgenus *Allopogostemon* which consists of most non-patchouli species of *Pogostemon* sensu stricto. It is a diverse group with well marked species. Section *Racemosus* has eleven species in southern India, five species from the Philippines, and one from southern Africa. Species of section *Zygocalyx* show a trend towards having a two-lipped calyx, with *P. litigious* the most extreme. This section is centred on an area from the eastern Himalayas to Yunnan and Thailand but includes three species endemic to Java, Borneo, and Sri Lanka respectively. Section *Zygocalyx* shares some characters with subsection *Glabriusculus* of section *Racemosus*. *Pogostemon wightii* Benth. of section *Zygocalyx* has a similar shaped corolla to that of species of subsection *Glabriusculus*. The calyx of *P. reflexus* Benth. and *P. speciosus* Benth. of subsection *Glabriusculus* has some teeth rather subulate and fringed by bristles like section *Zygocalyx*. The pattern of hairs on the interior of the calyx of these two groups is homologous. *Pogostemon paludosus* Benth. of subsection *Racemosus* shares characters with subsection *Glabriusculus*, by having stalked glands on the nutlets, and section *Zygocalyx*, by having a somewhat asymmetrical calyx, but it has moniliform hairs on the stamens and lacks subulate teeth, the key characteristics of these taxa.

Most species of subgenus *Dysophylla* have a corolla in which the separate lobes of the upper lip and the single lobe of the lower lip are approximately equal, and are shaped so that the corolla has a symmetry which is nearly radial. Many have linear to linear-lanceolate leaves. These are useful key characters but there are a number of different species in section *Verticillatus*: *Pogostemon andersonii* (Prain) Press, which has two opposite leaves at each node and *P. trinervis* Chemsir. ex Press, which has orbicular leaves.

Section *Dysophyllus* is a poorly delimited group. It includes species intermediate between section *Verticillatus* and subgenera *Pogostemon* and *Allopogostemon*. The boundary between *Dysophylla* and *Pogostemon* sensu stricto has taxed previous workers. It has only been resolved here by recognizing section *Dysophyllus* for a group of heterogeneous species which do not fit easily into either subgenus. Emphasis has been placed here on calyx characters so that species in section *Dysophyllus* may have varied characters of *Pogostemon* sensu stricto, but have the broadly conical and translucent calyx of *Dysophylla*; so, for example, *P. amaranthoides* Benth. which has normally been placed within *Pogostemon* sensu stricto is here placed in subgenus *Dysophyllus*.

*Pogostemon mutamba* (Hiern) G. Taylor and *P. micangensis* G. Taylor, the African species, have also traditionally been placed in *Pogostemon* sensu stricto. They have the normal zygomorphic corolla of other *Pogostemon* species from subgenera *Pogostemon* and *Allopogostemon*, but although they also have a calyx with intercostal veins it is very strongly conical/campanulate like species of subgenus *Dysophylla*.

Section *Dysophylla* is clearly not a natural group and in the future

will be subdivided into several smaller taxa. Data to enable stable groups to be erected are not yet available.

## CHARACTER VARIATION

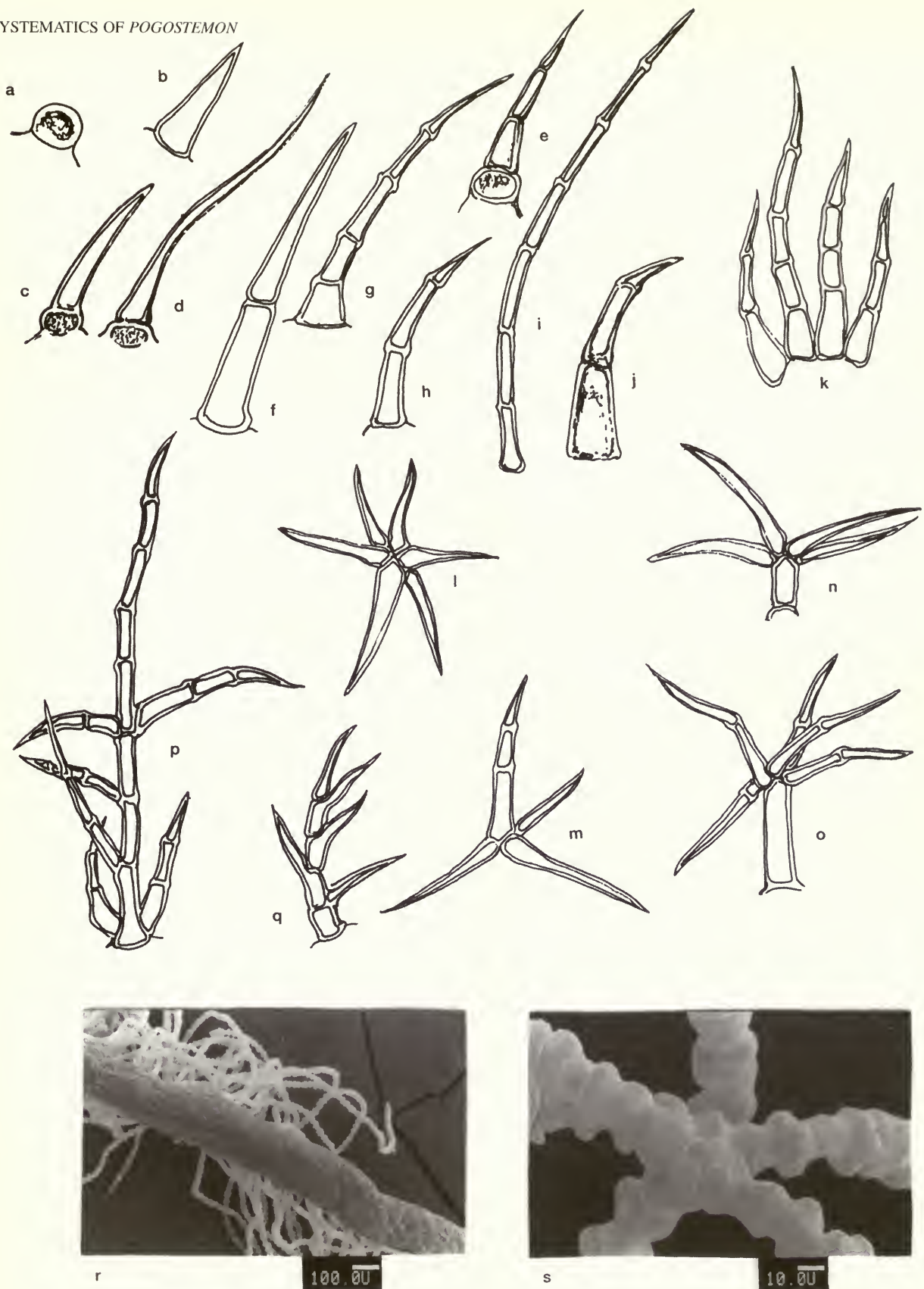
### Indumentum and glands

A significant feature of the genus is the nature and distribution of the hairs. Most important are the moniliform hairs found on the filaments of almost all species (Fig. 1). Hairs of various other kinds, simple, stellate, fruticose, and dendromorphic, have been found elsewhere on plants (Fig. 1). In most species similar kinds of hairs can be found on all parts of the plant but rarely different parts of the plant have different hairs. Hairs may be simple or branched. Many have a swollen basal cell which has different cell contents from the distal part. These may be glandular trichomes. Hairless glands may be found intermixed with hairs (Fig. 1).

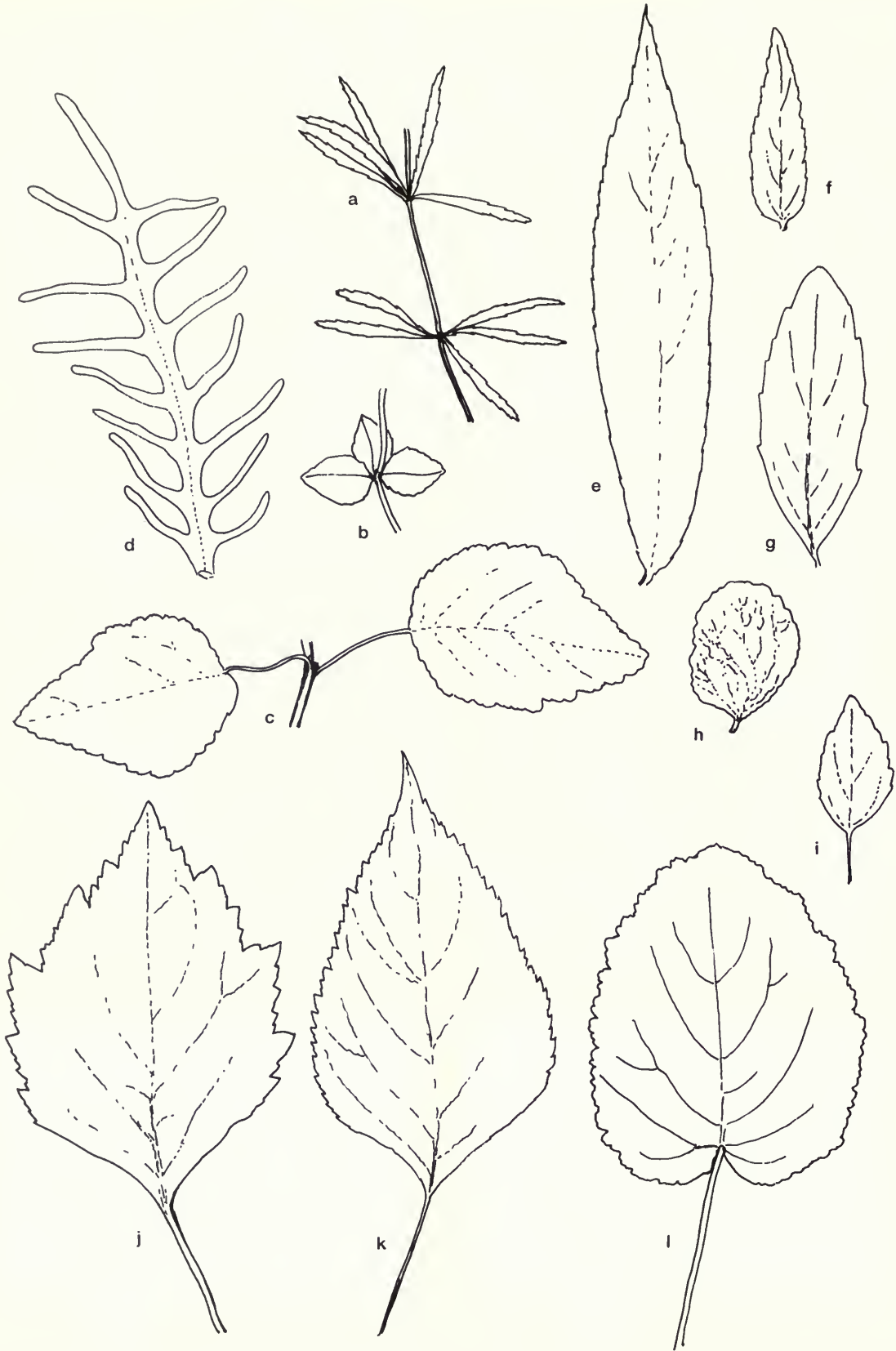
Simple trichomes are either unicellular or uniseriate multicellular. They are elongated, broader at the base, and gradually tapering towards the apex. In multicellular types they are generally slightly swollen at the septa, forming a node. All taxa have multicellular, simple trichomes except *Pogostemon koehneanus* and *P. peguanus* (Prain) Press which have unicellular hairs on stems, leaves, and inflorescence. Stellate trichomes have been found only in *P. tuberculosus* Benth. On most of the plant the hair branch which occupies the central position is 2-celled and longer than the others. The remaining lateral branches, which are unicellular, radiate from the central one, at 30–40° to the surface. Stellate hairs on the calyx have 2–3-celled central branches. Fruticose trichomes are composed of a bunch of branches, attached only at the base. The central branch is longer than the lateral branches and together they look like a bush. This type of trichome is found in *P. velatus* Benth. and *P. williamsii* Elmer. Press (1982) reported these trichomes as sessile branched hairs in comparison to dendromorphic trichomes because they are without a central boss and have long flexuous branches with each branch uniseriate and multicellular. However, the use of the term sessile is unfortunate because this is impossible to determine without branching. Dendromorphic trichomes are branched hairs in which the basal part is like the main trunk of a tree. This basal part gives rise to lateral branches of considerable length. The lateral branches are arranged either in opposite or alternate fashion. Fruticose and dendromorphic trichome types occur in combination in *P. velatus* and *P. williamsii*, although the leaves and calyces of *P. williamsii* have only dendromorphic trichomes. The abaxial leaf surface of *P. elatispicatus* Bhatti & Ingr., has both simple and dendromorphic hairs, whereas other parts of the plant have only simple hairs.

### Stem

Collectors' remarks on herbarium sheets sometimes provide helpful notes about the form and habit of the plant. The stem is erect in most species. The exceptions are taxa like *Pogostemon auricularius*, which has an aquatic habit. In nature the stems of this species are prostrate and root at the nodes; it is a straggling plant and spreads over an area of 1–2 m in marshy places with the erect flowering branches arising from the main stem in water. The part of the plant which is used to prepare a herbarium sheet is an erect branch but here it has been considered as an erect stem. *P. rupestris* Benth. roots at the nodes. Many species of subgenus *Dysophyllus*, especially those of section *Verticillatus*, have a weak stem, sometimes contracted at the internodes and obviously procumbent. In contrast, species of



**Fig. 1** Indumentum types observed in *Pogostemon*: (a) gland without a hair; (b-d) unicellular trichomes, (c, d) with basal glandular cell; (f-j) uniseriate multicellular trichomes, (e) with basal glandular cell; (k) fruticose trichomes; (l-o) stellate trichomes, (l, n) with unicellular arms, (m, o) with some multicellular arms, (l, m) sessile, (n, o) stalked; (p, q) dendromorphic, (p) branches opposite, (q) branches alternate; (r, s) moniliform filament hairs.



**Fig. 2** Leaf forms found in *Pogostemon*: (a) whorl of five leaves at a node; (b) whorl of three leaves at a node; (c) two leaves opposite at a node; (a, e, f) linear to linear-lanceolate; (b, c, g-l) ovate to lanceolate; (d) pinnatifid; (l) base cordate; (b-k) base attenuate to truncate; (a, b, e-h) sessile to subsessile; (c, h-l) petiolate.



subgenus *Pogostemon* are large semi-woody shrubs or subshrubs. Most other species are herbs.

Normally the upper part of the stem towards the inflorescence region is more hairy than lower parts. A study of hairs on the stem showed a glabrous stem in *Pogostemon glaber* Benth., *P. fraternus* Miq., *P. nelsonii* Doan, *P. travancoricus* Beddome, *P. pumilus* (Graham) Press, *P. lythroides* (Diels) Press, *P. helferi* (Hook.f.) Press, *P. yatabeanus* (Makino) Press, *P. sampsonii* (Hance) Press, *P. stocksii* (Hook. f.) Press, *P. linearis* (Benth.) Kuntze, *P. pressii* Panigrahi, and *P. faurei* (Léveillé) Press. Stellate trichomes have been found on *P. tuberculosus*. Fruticose and dendromorphic trichomes are found on *P. velatus* and *P. williamsii*. The remaining taxa have simple hairs. Unicellular hairs have been found on the stems of *P. peguanus* and *P. koehneanus*.

## Leaves

Most species have a pair of opposite leaves at each node but among the species of section *Verticillatus* the number of leaves at each node ranges from three to more than ten, with four as the most common number. The number of leaves is normally constant within species but variation has been noticed in *Pogostemon quadrifolius* which has most nodes with whorls of four leaves, but two leaves at some nodes. *Pogostemon yatabeanus*, *P. sampsonii*, *P. crassicaulis*, *P. koehneanus*, and *P. trinervis* have three leaves in a whorl. *Pogostemon cruciatus* and *P. stocksii* have five leaves in a whorl. Eight or more leaves are present in *P. erectus*, *P. deccanensis* (Panigrahi) Press, and *P. stellatus*.

All species have simple leaves, except *Pogostemon tisserantii* (Pellegr.) Bhatti & Ingr., which has pinnatifid leaves. Leaves may be ovate, lanceolate, orbicular, cordate, elliptic, ovate-lanceolate, or linear (Fig. 2). The majority of the members of subgenera *Pogostemon* and *Allopogostemon* have an ovate to lanceolate leaf shape, although *P. rotundatus* Benth. has orbicular leaves and *P. speciosus* has cordate leaves. Species belonging to subgenus *Dysophyllus* usually have linear to linear-lanceolate leaves. Most exceptions are found in section *Dysophyllus*: *P. auricularius*, *P. myosuroides* (Benth.) Kuntze, and *P. salicifolius* Dalzell ex Hook.f.) El Gazzar & L. Watson have a lanceolate to linear-lanceolate leaf shape while an elliptic leaf shape has been recorded from *P. mutamba* and *P. glabratus* Chermisr. ex Press. *Pogostemon trinervis* is unusual in section *Verticillatus* because its leaves are more or less orbicular. Most species have a cuneate leaf base but *P. speciosus* has leaves which are cordate at the base. Leaves with a rounded base have been found in *P. atropurpureus* Benth., *P. brachystachyus*, *P. macgregorii*, *P. mollis* Benth., *P. philippinensis* S. Moore, *P. pressii*, and *P. trinervis*.

The leaf apex is commonly acute or acuminate, but an obtuse apex has been recorded from *Pogostemon brachystachyus*, *P. cablin*, *P. glaber*, *P. mollis*, *P. nepetoides* Stapf., *P. nigrescens* Dunn, *P. rotundatus*, *P. speciosus*, *P. velatus*, *P. peguanus*, *P. pentagonus* (C.B. Clarke ex Hook.f.) Kuntze, *P. quadrifolius*, *P. sampsonii*, *P. trinervis*, and *P. cruciatus*.

Dentate, double dentate, crenate, double crenate, inciso-crenate, and serrate margins have been recorded. An entire/revolute margin is found in some species of subgenus *Dysophyllus*, but not elsewhere. The leaf margin in *Pogostemon cristatus* Hassk., *P. formosanus* Oliver, and *P. gardneri* Hook.f. has a deep incision, and is described as inciso-crenate.

Petiolate, subsessile (petiole < 5 mm), and sessile leaves have been observed. Most of the members of subgenus *Dysophyllus* have a sessile leaf, a character state not found outside this subgenus, although *Pogostemon auricularius*, *P. glabratus*, *P. mutamba*, *P. myosuroides*, *P. micangensis*, *P. quadrifolius*, and *P. salicifolius*

have a subsessile leaf and *P. barbatus* Bhatti & Ingr. and *P. amaranthoides* are petiolate. Petiolate leaves are normal in other subgenera with only *P. nigrescens*, *P. strigosus* (Benth.) Benth., and *P. velatus* having a subsessile leaf.

The leaves of *Pogostemon nelsonii* are glabrous but all other species of subgenus *Pogostemon* are hairy. Most species of subgenus *Allopogostemon* are hairy but *P. travancoricus* has glabrous leaves. Several species of subgenus *Dysophyllus* have glabrous leaves, including *P. pressii*, *P. helferi*, *P. pentagonus*, *P. sampsonii*, and *P. verticillatus*.

The abaxial leaf surface of many species is densely hairy when compared to the adaxial surface. The veins are more hairy than the lamina on both the adaxial and abaxial surfaces.

## Inflorescence

The inflorescence in *Pogostemon*, like most Labiatae, is a terminal, verticillate thyrs. This has a spike-like appearance. Inflorescences have been categorized into three kinds: a single terminal spike, a terminal spike with two lateral spikes, and a terminal spike with more than two lateral spikes (Fig. 3).

In subgenus *Pogostemon* the inflorescence is branched; the terminal verticillaster is usually accompanied by more than two lateral verticillasters, less frequently by just two laterals, but in *P. purpurascens* it is simple. Branched inflorescences are found in a few species in other subgenera, but most have a single verticillaster.

The verticillaster is commonly very dense but in some species the lowest verticils are arranged laxly and the upper part densely. A few species, especially in subgenus *Allopogostemon*, have a lax verticillaster throughout.

## Bracts and bracteoles

The arrangement, shape, and persistence of the bracts and bracteoles is very variable, even on a single plant. In some species bracts are large and there is a continuum in size and shape between lower vegetative leaves on an inflorescence and the bracts associated with the verticils. This pattern is common in subgenus *Pogostemon*. More frequently bracts are distinctly different from vegetative leaves: smaller, narrower, and less petiolate. Sometimes they are indistinctly toothed. In *P. purpurascens*, *P. cablin*, *P. nepetoides*, and *P. nelsonii* they are distinctly toothed. Deeply cleft, two-lobed bracts can be found in *P. villosus* Benth. and *P. paniculatus*. In subgenus *Pogostemon* the bracts and bracteoles are smallest and narrowest in *P. tuberculosus*, *P. formosanus*, *P. elsholtzioides* Benth., and *P. dielsianus* Dunn. Bracts in the other subgenera are normally narrow, linear-lanceolate to linear, and filiform bracteoles are found. In section *Verticillatus* several species, including *P. helferi*, *P. pumilus*, *P. stocksii*, *P. erectus*, *P. stellatus*, and *P. deccanensis* the bracts/bracteoles are spatulate. Bracts and bracteoles are normally densely hairy.

## Calyx

The calyx is either infundibular, tubular or campanulate. In subgenus *Dysophyllus* the calyx is infundibular with a wide diameter, greater than the length of the tube. In subgenus *Allopogostemon* the calyx is normally tubular or infundibular, and then two-lipped and with a circumference less than or equal to the length of the calyx tube. In subgenus *Pogostemon* the calyx is normally infundibular and has a diameter narrower than the tube length.

*Pogostemon* normally has a calyx with five teeth. Some specimens of *P. atropurpureus*, *P. brachystachyus*, *P. micangensis*, and *P. philippinensis* have 5–7 toothed calyces. Extra teeth are particularly common in *P. micangensis* so that the calyx toothing is rather



Fig. 3 Inflorescence types observed in *Pogostemon*; (a, d, g) single spike; (b, e) with two lateral spikes; (c, f) with branched lateral spikes; (b, c, f, g) spikes dense; (a) spike lax below, dense above; (d, e) lax.



irregular. In *P. faurei* some of the calyces have four teeth. Calyx teeth are normally either broadly or narrowly triangular.

Species of section *Zygocalyx* have the most distinct calyx. The calyx is asymmetrical and two-lipped, with the two lower teeth narrower than the upper three, and the teeth tips drawn out into a narrow point (subulate). This condition is most pronounced in *Pogostemon litigiousus* but is seen to a lesser extent in *P. fraternus*, *P. brachystachyus*, *P. wightii*, *P. nigrescens*, *P. strigosus*, *P. menthoides*, *P. hirsutus* Benth., and *P. macgregorii*.

Calyx venation is a very important character for delimiting subgeneric groups. All species have five prominent veins along the ribs of the calyx. In subgenus *Dysophylla* the only veins which are obvious are those at the ribs of the calyx and the intercostal region is thin and translucent. *Pogostemon micangensis* has the same pattern but with irregular toothing so that there may be an intervening rib which does not end in a tooth. In subgenus *Pogostemon*, as well as the five main rib veins, there are numerous secondary veins or lines of elongated cells in the intercostal region, running in parallel to the ribs, and converging at the teeth sinuses. In the distal part of the tube and in the teeth secondary branches arise from the rib vein and run to the thickened margin of the calyx. The calyx tube is incrassate and opaque with the exterior often densely covered with hairs. In subgenus *Allopogostemon* two patterns may be observed: either the calyx has five midrib veins plus five other strong intercostal veins, terminating at each sinus; or there is a more reticulate pattern of venation with five rib veins plus some other intercostal veins. In the intercostal region the number of veins is variable and the veins interconnect in a reticulate fashion with the rib veins. The intercostal region is thinner than in subgenus *Pogostemon*, but papery rather than translucent as in subgenus *Dysophyllus*.

Calyx hairiness is an important character. *Pogostemon elsholtzioides*, *P. nelsonii*, *P. nepetoides*, and *P. travancoricus* have a glabrous margin to the teeth. The presence of a row of hairs on the inner side of the margin has been recorded in *P. dielsianus* and *P. formosanus*. Hairs originating slightly inside and outside the margin of the teeth have been recorded in *P. philippinensis*, *P. strigosus*, and *P. tuberosus*. Hairs on the margin are either similar to those on the exterior of the calyx and ciliate, or they are stiff and bristle-like. The latter are found in section *Zygocalyx*.

The exterior of the calyx is normally hairy to very hairy. In most species it is the distal part of the exterior calyx tube which is hairy. *Pogostemon auricularius*, *P. barbatus*, *P. glabratus*, and *P. ciliatus* Bhatti & Ingr. have just the teeth hairy and *Pogostemon travancoricus* is glabrous.

The majority of the hairy species have simple, uniseriate, multicellular hairs in which the basal cells are broad and apical cells sharply pointed. Both fruticose and dendromorphic trichomes have been found in *Pogostemon velatus*, while in *P. williamsii*, which is considered by various authors as synonymous with *P. velatus*, only fruticose trichomes like those on its leaves are found. *Pogostemon tuberosus* possesses stellate trichomes. These trichomes differ from those on other parts of the plant, having a central 3-celled, rather than 2-celled, branch. In subgenus *Dysophyllus* most of the taxa have simple, multicellular hairs except *P. faurei*, *P. koehneanus*, and *P. peguanus*, which have unicellular hairs on the outer surface of the calyx. In subgenus *Dysophyllus* hairless glands are obvious as little patches of circular cells with yellowish cell contents. These are probably present on all species but are not so obvious on the thicker and opaque calyces of subgenera *Pogostemon* and *Allopogostemon*.

Observation of hairs within the calyx is difficult because they can be very fine and sparsely distributed here. Where visible, the distribution of hairs in the distal part provides an important character. The hairs may be spread over the teeth and down the tube or confined

more or less distally, in some species, just to the tip of the teeth, as in *Pogostemon membranaceus* Merr. and *P. petiolaris* Benth.

An alternate pattern of hair distribution, which can be confused with the last condition, is where the hairs form a wavy annulus around the top of the calyx tube. In these species the most dense hairs are often found at the teeth sinuses. The annulus varies from being very strongly developed in *Pogostemon speciosus*, so that tufts of hairs seem to spill out at the teeth sinuses, to poorly developed in *P. strigosus*, which has only a few hairs present, mainly at the sinuses of the teeth. In section *Zygocalyx* an annulus of hairs has been observed in the throat of the calyx in *P. wightii*, *P. brachystachyus*, *P. fraternus*, *P. litigiousus*, *P. macgregorii*, *P. menthoides*, and *P. nigrescens*. This character state may be homologous to that seen in section *Racemosus* subsection *Glabriusculus*, in *P. atropurpureus*, *P. reflexus*, and *P. speciosus* which have tufts of hairs at the tips of the teeth and a line of hairs running down the edge of the teeth to the sinus.

The patterns described above are clearly different from that seen in subgenus *Pogostemon*, where hairs are more evenly distributed within the calyx, over the teeth, and sometimes down into the tube including the region of the ribs. Normally the upper part of the calyx tube and teeth are hairy or only the teeth are hairy. *Pogostemon paniculatus*, *P. pubescens* Benth., *P. purpurascens*, and *P. wattii* C.B. Clarke have the entire calyx tube and teeth hairy. *Pogostemon gardneri* has the tube but not the teeth hairy.

In subgenus *Dysophyllus* the interior of the calyx is glabrous except for a few species which have the inner teeth hairy.

## Corolla

The corolla consists of two parts, the tube and the two-lipped limb. The upper lip is three lobed. The outer surface of the upper lip, and sometimes also the lower lip, is normally hairy. *Pogostemon tuberosus*, *P. auricularius*, *P. rogersii* N.E. Br., *P. mutamba*, and *P. paludosus* have hairs only on the central lobe of the upper lip.

The corolla tube varies in length from shorter to longer than the limb. The tube may have a narrow diameter relative to its length and be uniformly tubular or become wider in its distal part. The relative size of the lower and upper lips and the size and shape of the upper lobes provide useful characters for distinguishing species. The dissected corolla reveals that there are several prominent veins (12 to 16) in the tube. Four of these give rise to staminal filaments. The remaining veins continue as midribs or lateral veins of the lobes in the upper and lower lip of the corolla.

The site of filament attachment in the corolla tube is closely correlated to the total length of the corolla. For example, the total length of the corolla in *Pogostemon amaranthoides* is about 2.6 mm and the tube length up to the site of filament attachment is about 1.0 mm. In *P. velatus* corolla length is about 8.0 mm and the site of filament attachment is 3.5 mm up the tube. The length of the exerted part of the filament is more or less constant within species but varies between species, ranging from hardly exerted up to 5.0 mm.

The presence of hairy filaments gave *Pogostemon* its name. Moniliform hairs are found on all four filaments. The hairs are unilaterally distributed. Moniliform hairs are only absent from section *Glabriusculus*, namely *P. atropurpureus*, *P. speciosus*, *P. travancoricus*, and *P. reflexus*, but these have a few simple hairs scattered over the filaments. Simple hairs are found mixed with moniliform hairs in *P. hirsutus*. *Pogostemon menthoides* has only a few moniliform hairs present.

In subgenera *Dysophyllus* and *Pogostemon* filaments are normally glabrous in the lower part and at the base but a few simple hairs may be found here. Most species in subgenus *Allopogostemon* have the filament base villous with short sharp hairs. The central/upper two filaments are generally more hairy than the outer/lower two.



Gynoeceum

The style in all taxa under examination is terminated by a bifid stigma with equal or unequal lobes. Simple, uniseriate 2–3-celled hairs have been observed on the stigma lobes of *Pogostemon ciliatus*. The maximum length of lobes is 1.9–2.1 mm, recorded from *P. nepetoides*. On one specimen of *P. elsholtzioides* flowers with both bifid and three-lobed stigmas have been observed. The flowers with three-lobed stigmas have six nutlets.

Some glands have been found on the ovary in *Pogostemon atropurpureus*, *P. reflexus*, *P. speciosus*, and *P. travancoricus*.

The disc is four-chambered where each of the ovary segments fit. These chambers are normally equal and regular in shape in all taxa. An asymmetrical disc, with one arm of the disc elongated, has been found in *Pogostemon erectus*, *P. deccanensis*, and *P. stellatus* of subgenus *Dysophylla*.

Table 1 Nutlet surface morphology in *Pogostemon*.

Nutlet surface morphology	Species
smooth	<i>P. helferi</i> , <i>P. erectum</i> , <i>P. salicifolius</i> , <i>P. stellatus</i> , <i>P. pressii</i> , <i>P. peguanus</i> , <i>P. trinervis</i> , <i>P. stocksii</i>
punctulate (smooth surface with tiny scattered dots)	<i>P. amaranthoides</i> , <i>P. benghalensis</i> , <i>P. gardneri</i> , <i>P. glaber</i> , <i>P. hispidus</i> , <i>P. paniculatus</i> , <i>P. plectranthoides</i> , <i>P. pubescens</i> , <i>P. villosus</i>
smooth-lineate (thin lines running in parallel on the smooth surface)	<i>P. koehneanus</i>
smooth-reticulate (smooth surface is covered by a thin lined network)	<i>P. deccanensis</i>
undulate	<i>P. crassicaulis</i>
foveate (pitted)	<i>P. hispidus</i>
smooth with thinly scattered small pits	<i>P. nelsonii</i>
reticulate with punctate walls	<i>P. purpurascens</i>
reticulate-punctate	<i>P. pumilus</i> , <i>P. faurei</i>
granulate (evenly covered with closely spaced grains but without reticulate appearance)	<i>P. tuberculosus</i> , <i>P. verticillatus</i>
reticulate (unornamented)	<i>P. auricularius</i> , <i>P. brachystachyus</i> , <i>P. membranaceus</i> , <i>P. nigrescens</i> , <i>P. philippinensis</i> , <i>P. hirsutus</i>
reticulate with secondary reticulations	<i>P. nilagiricus</i> , <i>P. petiolaris</i> , <i>P. strigosus</i> , <i>P. wightii</i>
reticulate-foveate with warty patches	<i>P. cristatus</i>
rugose	<i>P. aquaticus</i>
zig-zag channels	<i>P. ciliatus</i>
ruminate, penetrated by irregular channels running in different directions, showing eroded features	<i>P. delsianus</i> , <i>P. elsholtzioides</i> , <i>P. griffithii</i>
smooth, covered by more or less circular scales	<i>P. rotundatus</i>
small tubercles	<i>P. myosuroides</i> , <i>P. elatispicatus</i> , <i>P. strigosus</i> , <i>P. velatus</i> , <i>P. williamsii</i> , <i>P. quadrifolius</i>
stalked, cup-like glands	<i>P. speciosus</i> , <i>P. reflexus</i> , <i>P. travancoricus</i> , <i>P. atropurpureus</i> , <i>P. paludosus</i>

Nutlets

Only minor variations were observed in nutlet surface characteristics within species (Figs 14–40). The majority of nutlets from species belonging to subgenus *Dysophyllus* are oblong. Ellipsoid to ellipsoid-oblong nutlets have been found in *Pogostemon linearis* and *P. verticillatus*. Orbicular and ovoid nutlets have been found in *P. deccanensis* and *P. tisserantii* respectively. In subgenera *Pogostemon* and *Allopogostemon* a wide range of shapes has been observed: ovoid, orbicular, oblong, obovoid, lanceolate to linear-lanceolate, ellipsoid to ellipsoid-oblong, ellipsoid-fusiform, and ‘D’-shaped.

A scanning electron microscope study of the nutlet surface revealed several different types of nutlet epidermal structure (Table 1). Few patterns correlate closely with groups. A smooth surface is common in species of subgenus *Dysophyllus*. Subsection *Glabriusculus* is characterized by having glands on the nutlets, a character also found in *Pogostemon paludosus*.

Nutlet colour could not always be ascertained because very mature specimens are required and of course mature nutlets fall out of the flowers.

SYSTEMATIC ACCOUNT

POGOSTEMON Desf. in *Mém. Mus. Hist. nat. Paris* 2: 154 (1815).

Inflorescence a single, spike-like verticillaster or with two or more lateral verticillasters. Leaves sessile or petiolate. Bracts and bracteoles not membranous, persistent. Calyx 5-toothed; veined within, glabrous or hairy within, densely or sparsely hairy outside. Corolla 4-lobed, three lobes forming upper lip, lower lip single-lobed; exterior of upper lip densely or sparsely hairy, lower lip glabrous or sparsely hairy. Filaments in two pairs, inserted at the same height or at different heights in the tube, mostly unequal in length, exerted; anthers unilocular; moniliform hairs present towards the middle (most species) or with a few fine simple hairs, basal part glabrous or with a few simple hairs, or densely villous, and then all bases equally hairy or only two hairy. Style exerted; stigma with two equal or unequal lobes. Disc symmetrical or asymmetrical. Nutlets 4, rarely one.

Key to subgenera, sections, and subsections

1. Calyx broadly conical, diameter greater than length, length < 4 mm, five veins only, thin and translucent (except *P. micangensis* and *P. mutamba*); calyx teeth normally ≤ 1 mm; leaves normally sessile or subsessile (petiole < 5 mm) (III. subgenus **Dysophyllus**) ..... 2  
  
Calyx tubular, diameter narrower than length, length ≥ 4 mm, five main veins but with intercostal veins, thick or papery; calyx teeth normally > 1 mm; leaves normally petiolate ..... 3
2. Leaves linear or linear-lanceolate, sessile, base truncate, rounded or cuneate, verticillate, > 2 per node (rarely 2 opposite leaves at each node) ..... IIb. section **Verticillatus**  
  
Leaves lanceolate, elliptic, ovate, or clavate, petiolate, base usually cuneate, rarely rounded, 2 opposite leaves at each node (rarely some nodes with 4) ..... IIIa. section **Dysophyllus**
3. Calyx with 5 main rib-veins and multiple parallel intercostal secondary veins meeting at the sinuses; calyx tube often with scattered hairs within; bracts and bracteoles large, equalling or exceeding calyx, frequently broadly lanceolate or bifid and toothed or lobed, less frequently narrowly lanceolate; lateral verticillasters 2 or more, or rarely an unbranched verticillaster but then filament bases normally glabrous or with long simple hairs ..... I. subgenus **Pogostemon**

- Calyx with 5 main rib veins plus isolated, more or less branched intercostal veins from sinuses of teeth; annulus of hairs present around top of calyx tube and teeth; bracts and bracteoles linear to linear-lanceolate, large or small; inflorescence an unbranched verticillaster, or if branched then filament bases glabrous or densely villous (II. subgenus **Allopogostemon**) ..... 4
4. Calyx more or less 2-lipped; at least 2 calyx teeth awl-shaped, the margins fringed by stiff bristle-like hairs ..... IIb. section **Zygocalyx**
- Calyx symmetrical; calyx teeth triangular with a fringe of fine hairs (IIa. section **Racemosus**) ..... 5
5. Moniliform staminal hairs present ..... IIai. subsection **Racemosus**
- Moniliform staminal hairs absent ..... IIaii. subsection **Glabriusculus**

## Key to species

1. Leaves in opposite pairs ..... 2
- Leaves in whorls of three or more, at least at some nodes ..... 59
2. Inflorescence an unbranched verticillaster ..... 3
- Inflorescence branched, with two or more lateral verticillasters ..... 32
3. Stamens lacking moniliform hairs; ovary/nutlets with cup-shaped glands ..... 4
- Stamens with moniliform hairs; ovary and nutlets usually without cup-shaped glands ..... 7
4. Inflorescence lax; calyx exterior glabrous ..... 36. **P. travancoricus**
- Inflorescence dense; calyx exterior hairy ..... 5
5. Petiole > 4 cm long; hairs on stem and inflorescence 8–9 celled ..... 35. **P. speciosus**
- Petiole ≤ 4 cm long; hairs on stem and inflorescence 5–6 celled ..... 6
6. An annulus of hairs in the calyx throat, calyx teeth conspicuously hairy; filaments inserted at the same height ..... 37. **P. reflexus**
- An annulus of hairs around the calyx throat, conspicuously tufted at teeth sinuses; filaments inserted at different heights ..... 38. **P. atropurpureus**
7. Calyx tubular-inflated, asymmetrical, with 5 main veins and a variable number of intermediate, reticulately-branched sinus veins; teeth unequal, lanceolate-subulate, with a margin of stiff bristles ..... 8
- Calyx infundibular, tubular or tubular-inflated but symmetrical, with 5 main rib veins, with or without sinus veins; teeth equal, with or without a margin of fine white hairs ..... 14
8. Inflorescence dense, continuous ..... 9
- Inflorescence with at least the lower verticil separate from the others ..... 11
9. Leaf margin dentate; calyx < 4 mm long; corolla < 5 mm long; moniliform hairs few on filaments ..... 40. **P. menthoides**
- Leaf margin serrate; calyx ≥ 4 mm; corolla ≥ 5 mm long; moniliform hairs dense on filaments ..... 10
10. Leaves subsessile, lanceolate; petiole < 5 mm long; inflorescence > 50 mm long ..... 47. **P. strigosus**
- Leaves petiolate, ovate; petiole ≥ 5 mm long; inflorescence ≤ 50 mm long ..... 43. **P. hirsutus**
11. Inflorescence > 100 mm long ..... 45. **P. brachstachyus**
- Inflorescence ≤ 100 mm long ..... 12
12. Verticils arranged densely in upper part ..... 42. **P. macgregorii**
- Verticils arranged laxly throughout ..... 13

13. Calyx strongly asymmetrical and 2-lipped; filament bases glabrous ..... 41. **P. litigiousus**
- Calyx weakly asymmetrical and 2-lipped; filament bases villous ..... 44. **P. wightii**
14. Calyx infundibular, with 5 main veins only, translucent ..... 15
- Calyx with 5 main veins and intermediate veins running to the sinuses, texture thick ..... 20
15. Corolla lower lip shorter than upper; filaments arising at two levels ..... 55. **P. micangensis**
- Corolla lips equal in length; filaments arising at the same level ..... 16
16. Petiole > 5 mm long ..... 50. **P. barbatus**
- Petiole ≤ 5 mm long ..... 17
17. Margin of calyx teeth glabrous ..... 49. **P. glabratus**
- Margin of calyx teeth fringed with white hairs ..... 18
18. Inflorescence < 30 mm long ..... 62. **P. andersonii**
- Inflorescence ≥ 30 mm long ..... 19
19. Exterior of calyx very hairy with dense long hairs at base, teeth hairy within ..... 53. **P. salicifolius**
- Exterior of calyx with few hairs but many glands, teeth glabrous within ..... 48. **P. auricularius**
20. Calyx ≤ 4 mm long; length of corolla tube less than or equal to circumference ..... 21
- Calyx > 4 mm long; length of corolla tube greater than circumference 23
21. Inflorescence > 50 mm long ..... 34. **P. paludosus**
- Inflorescence ≤ 50 mm long ..... 22
22. Stem hairy; inflorescence lax below, dense above ..... 23. **P. mollis**
- Stem glabrous except at the nodes; inflorescence lax throughout ..... 26. **P. rupestris**
23. Calyx with 5 rib veins and minor parallel secondary veins ..... 8. **P. purpurascens**
- Calyx with 5 rib veins and 5 sinus veins ..... 24
24. Calyx teeth shallowly triangular ..... 25
- Calyx teeth deeply triangular ..... 29
25. Indumentum of dendromorphic and fruticose hairs; nutlet surface spinulose ..... 26
- Indumentum of simple, multicellular hairs; nutlet surface reticulate to reticulate-foveate ..... 28
26. Petiole c. 5 mm long ..... 30. **P. velatus**
- Petiole > 10 mm long ..... 27
27. Inflorescence > 150 mm long, verticils arranged evenly and relatively laxly throughout spike ..... 33. **P. elatispicatus**
- Inflorescence ≤ 150 mm long, lax below or dense throughout ..... 31. **P. williamsii**
28. Inflorescence > 100 mm long, lax below, dense above ..... 29. **P. philippinensis**
- Inflorescence ≤ 100 mm long, dense throughout ..... 24. **P. vestitus**
29. Leaves orbicular ..... 28. **P. rotundatus**
- Leaves ovate ..... 30
30. Corolla > 7.5 mm long; tube long and narrow, c. 2 × limb ..... 30

- ..... 32. **P. membranaceus**  
Corolla < 7 mm long; tube relatively short and broad, < 2 × limb .. 31
31. Calyx c. 4.5 × 3.5 mm, with 10 main veins ..... 22. **P. nilagiricus**  
Calyx c. 5.0 × 5.2 mm, with 5 main veins, subsidiary veins indistinct ..... 25. **P. petiolaris**
32. Leaves subsessile, petiole < 5 mm long ..... 33  
Leaves petiolate, petiole ≥ 5 mm long ..... 36
33. Verticillasters lax below, dense above ..... 46. **P. nigrescens**  
Verticillasters dense throughout ..... 34
34. Verticillasters > 70 mm long ..... 54. **P. quadrifolius**  
Verticillasters ≤ 70 mm long ..... 35
35. Calyx < 2 mm long; corolla < 3 mm long ..... 52. **P. myosuroides**  
Calyx ≥ 2 mm long; corolla ≥ 3 mm long ..... 56. **P. mutamba**
36. Inflorescence lax, at least below ..... 37  
Inflorescence dense ..... 48
37. Inflorescence with two lateral verticillasters only .....  
..... 51. **P. amaranthoides**  
Inflorescence with more than two lateral verticillasters ..... 38
38. Calyx 10-veined, lobes unequal ..... 39  
Calyx with 5 main veins and numerous parallel veins or lines of cells in intercostal region, lobes equal ..... 40
39. Plant upright, up to 1 m tall; calyx with an annulus of hairs in the throat .....  
..... 39. **P. fraternus**  
Plant procumbent, rooting at nodes; calyx lacking an annulus of hairs in the throat ..... 27. **P. rogersii**
40. Indumentum on stem and leaves with 2–3-celled hairs .....  
..... 17. **P. formosanus**  
Indumentum on stem and leaves with more than 3 cells ..... 41
41. Petiole c. 6 mm long ..... 18. **P. elsholtzioides**  
Petiole > 10 mm long ..... 42
42. Inflorescence normally < 50 mm long ..... 43  
Inflorescence normally > 50 mm long ..... 44
43. Lateral verticillasters with a single verticil ..... 16. **P. championii**  
Lateral verticillasters with several verticils ..... 45
44. Stem weak, contracted at internodes; corolla up to 1 mm long .....  
..... 5. **P. cristatus**  
Stem strong and even; corolla < 10 mm long ..... 46
45. Verticils surrounded by broad ovoid bracts, some deeply cleft .....  
..... 7. **P. paniculatus**  
Verticils surrounded by elliptic-oblong bracts, sometimes toothed but never deeply cleft ..... 9. **P. cablin**
46. Corolla < 5 mm long; nutlet surface foveate ..... 14. **P. hispidus**  
Corolla > 5 mm long; nutlet surface punctulate ..... 47
47. Corolla 8–9 mm long; leaves with margin double dentate, apex acuminate, base cuneate; hairs on all parts of plant < 500 µm long .....  
..... 1. **P. benghalensis**  
Corolla 6–7 mm long; leaves with margin inciso-serrate, apex obtuse, base truncate; hairs on all parts of plant > 500 µm long .....  
..... 10. **P. nepetoides**
48. Lateral verticillasters two ..... 49  
Lateral verticillasters three or more ..... 52
49. Stem and leaf hairs 3-celled, < 500 µm long ..... 50  
Stem and leaf hairs 5–6 celled, > 500 µm long ..... 51
50. Stem dark reddish purple; petiole up to 40 mm long; calyx exterior sparsely hairy ..... 13. **P. glaber**  
Stem green; petiole up to 10 mm long; calyx exterior strongly hairy ..... 20. **P. griffithii**
51. Stem reddish; stem and leaf hairs > 1000 µm long ..... 6. **P. gardneri**  
Stem green; stem and leaf hairs < 1000 µm long ..... 14. **P. hispidus**
52. Calyx glabrous within ..... 53  
Calyx teeth hairy within ..... 54
53. Stem and leaves glabrous ..... 12. **P. nelsonii**  
Stem and leaves with stellate hairs ..... 19. **P. tuberculosus**
54. Calyx teeth shallow; lower lip of corolla relatively narrow, ≤ the upper lip ..... 55  
Calyx teeth deep; lower lip of corolla relatively wide, > the upper lip ..... 56
55. Corolla up to 8 mm long, lower lip > 2 mm long .....  
..... 3. **P. plectranthoides**  
Corolla up to 6.5 mm long, lower lip < 2 mm long .... 4. **P. pubescens**
56. Filaments arising at two heights ..... 57  
Filaments arising at the same height ..... 58
57. Calyx tube sparsely hairy within ..... 11. **P. heyneanus**  
Calyx tube glabrous within ..... 21. **P. dielsianus**
58. Calyx c. 3 mm long; corolla < 4 mm long ..... 15. **P. wattii**  
Calyx c. 4 mm long; corolla > 5 mm long ..... 2. **P. villosus**
59. Leaves linear to linear-lanceolate ..... 60  
Leaves lanceolate ..... 68. **P. koehneanus**  
Leaves pinnatifid ..... 57. **P. tisserantii**  
Leaves orbicular ..... 72. **P. trinervis**
60. Leaves ≥ 6 at each node ..... 61  
Leaves < 6 at each node ..... 64
61. Disc regular ..... 75. **P. stocksii**  
Disc irregular, with one arm elongated ..... 62
62. Calyx teeth hairy within ..... 76. **P. erectus**  
Calyx glabrous within ..... 63
63. Corolla very short, < 2 mm long, exerted portion of filament exceeding it in length ..... 77. **P. stellatus**  
Corolla > 2 mm long, exerted part of filament equalling it in length .....  
..... 78. **P. deccanensis**
64. Corolla with middle lobe of upper lip narrower than lateral lobes .. 65  
Corolla with middle lobe of upper lip wider than lateral lobes ..... 66
65. Inflorescence ≤ 40 mm long ..... 61. **P. pentagonus**  
Inflorescence > 40 mm long ..... 67. **P. peguanus**
66. Stigma hairy ..... 59. **P. ciliatus**  
Stigma glabrous ..... 67



67. Inflorescence with more than two lateral verticillasters ..... 68  
 Inflorescence unbranched or with 2 lateral verticillasters only ..... 69
68. Corolla  $\leq 2$  mm long ..... 70. *P. verticillatus*  
 Corolla  $> 2$  mm long ..... 79. *P. aquaticus*
69. Inflorescence with two lateral verticillasters only ... 69. *P. crassicaulis*  
 Inflorescence simple, unbranched ..... 70
70. Leaves in whorls of 3 ..... 71  
 Leaves in whorls of 4–5 ..... 72
71. Stem sparsely hairy; inflorescence  $\leq 35$  mm long .... 64. *P. sampsonii*  
 Stem glabrous; inflorescence  $> 35$  mm long ..... 65. *P. yatabeanus*
72. Calyx asymmetrical; lower corolla lips larger than upper ..... 73  
 Calyx symmetrical; lower corolla lips equal to or less than upper .. 74
73. Corolla  $\leq 1$  mm long ..... 71. *P. pumilus*  
 Corolla  $> 1$  mm long ..... 73. *P. helferi*
74. Leaf base rounded or truncate ..... 75  
 Leaf base cuneate ..... 76
75. Inflorescence  $\leq 20$  mm long ..... 58. *P. lythroides*  
 Inflorescence  $> 20$  mm long ..... 74. *P. pressii*
76. Leaf margin entire, revolute ..... 63. *P. cruciatus*  
 Leaf margin dentate ..... 77
77. Stem rooting at nodes, reddish brown; leaves sparsely hairy .....  
 ..... 60. *P. linearis*  
 Stem not rooting at nodes, not reddish brown; leaves glabrous .....  
 ..... 66. *P. faurei*

# I. Subgenus **POGOSTEMON** sensu Bhatti & Ingr.

*Pogostemon* subgenus *Paniculatae* Benth., pro parte.

Stem strong; leaves in opposite pairs at each node, distinctly petiolate (*P. griffithii* sessile), ovate, rarely lanceolate; inflorescence a verticillaster with two or more lateral verticillasters (*P. purpurascens* a single verticillaster), normally dense or with lower verticils laxly arranged, rarely lax throughout, with large, ovate, rarely lanceolate bracts, commonly lobed, deeply cleft and two-lobed, or toothed, equaling or exceeding the calyx. Calyx tubular-inflated to campanulate, with 5 rib veins, pinnately-branched in region of teeth, incrassate with lines of elongated cells parallel to ribs and coming together at sinuses of teeth; teeth triangular, hairy outside, coarsely hairy or glabrous within except at tips. Corolla tube usually equal to limb.

1. *Pogostemon benghalensis* (Burm.f.) Kuntze, *Rev. gen. pl.* 2: 529 (1891).

Figs 4a, 14a.

*Origanum benghalense* Burm.f., *Fl. indica*: 128, t. 38 f. 3 (1768).  
*Pogostemon parviflorus* Benth. in Wall., *Pl. asiat. rar.* 1: 31 (1830).  
*P. intermedius* Benth. in Wall., *Numer. List*: 2327 (1830).  
*P. frutescens* Graham, *Cat. pl. Bombay*: 149 (1839), pro parte.  
*P. purpuricaulis* Dalzell in Hooker's *J. Bot.* 2: 336 (1850), pro parte.  
*P. plectranthoides* auct. pro maj., non Desf.

Stem solid, angular; hairs 5-celled, *c.* 460  $\mu$ m long. Leaves ovate, 130  $\times$  60 mm, base cuneate, apex acuminate, margin double dentate; hairs 4-celled, *c.* 330  $\mu$ m long. Petiole 25 mm long; hairs 4-celled, *c.* 360  $\mu$ m long. Inflorescence a terminal spike, *c.* 70 mm long, with

more than two lateral spikes; hairs 5-celled, 1100  $\mu$ m long; bracts ovate, 6–7  $\times$  2–3 mm, hairy. Calyx tubular-inflated, 4.3  $\times$  4.0 mm, 5-veined; teeth and upper part of tube hairy outside,  $\pm$  glabrous within; teeth ciliate, longest tooth *c.* 1.2–1.3 mm long, 0.8–0.9 mm wide at base; outer hairs 2-celled, *c.* 200  $\mu$ m long. Corolla up to 8.7 mm long; lower lip *c.* 2.2  $\times$  2 mm; upper lip *c.* 2 mm across; central lobe *c.* 1.6  $\times$  0.7 mm; lobes hairy outside and scattered down the tube. Filaments inserted at different heights, the lowest at a height of 4 mm in the tube; filaments *c.* 5.1–7.0 mm long, exerted portion *c.* 2.3 mm; two filaments glabrous towards the base. Style *c.* 9.5 mm long; stigma lobes *c.* 1.2 mm. Disc *c.* 1 mm long. Nutlets 4, *c.* 1200  $\times$  700  $\mu$ m, obovoid, punctulate.

**DISTRIBUTION.** *Pogostemon benghalensis* grows in open *Bombax-Trewia* riverine forest on the bare flood plain in Nepal and is also found in India, Bangladesh, Burma, Thailand, Sri Lanka, and China.

**ETHNOBOTANY.** One of the patchouli species. *Pogostemon benghalensis* contains an astringent resin, an alkaloid, a yellow varnish of a slightly bitter taste and mouse-like odour of trimethylamine, and a volatile oil with an odour like that of cedar wood. Extracts are a stimulant and styptic. Fresh leaves are used to clean wounds and provide healthy granulation. *P. benghalensis* is a good source of pollen or nectar for bees, thereby providing panagol honey.

**SPECIMENS EXAMINED.** *Kerr* 10333 (BM), *Kerr* 17496 (BM), *Kingdon-Ward* 20299 (BM, K), *Troth* 677 (BM), *Troth* 750 (BM), *Wang* 30222 (BM).

*Pogostemon benghalensis* has previously been recorded as a synonym of *P. plectranthoides*, but they are distinct. However, it is possible that many records of this species from southern India and Sri Lanka are referable to *P. plectranthoides*. *Pogostemon benghalensis* has a corolla with a narrower cylindrical tube and a verticillaster which is generally less crowded than in *P. plectranthoides*. It is a variable species with smaller flowered variants (= *P. parviflorus* Benth.) with verticillasters less than 10 mm in diameter and purple-stemmed plants (= *P. purpuricaulis* Dalzell).

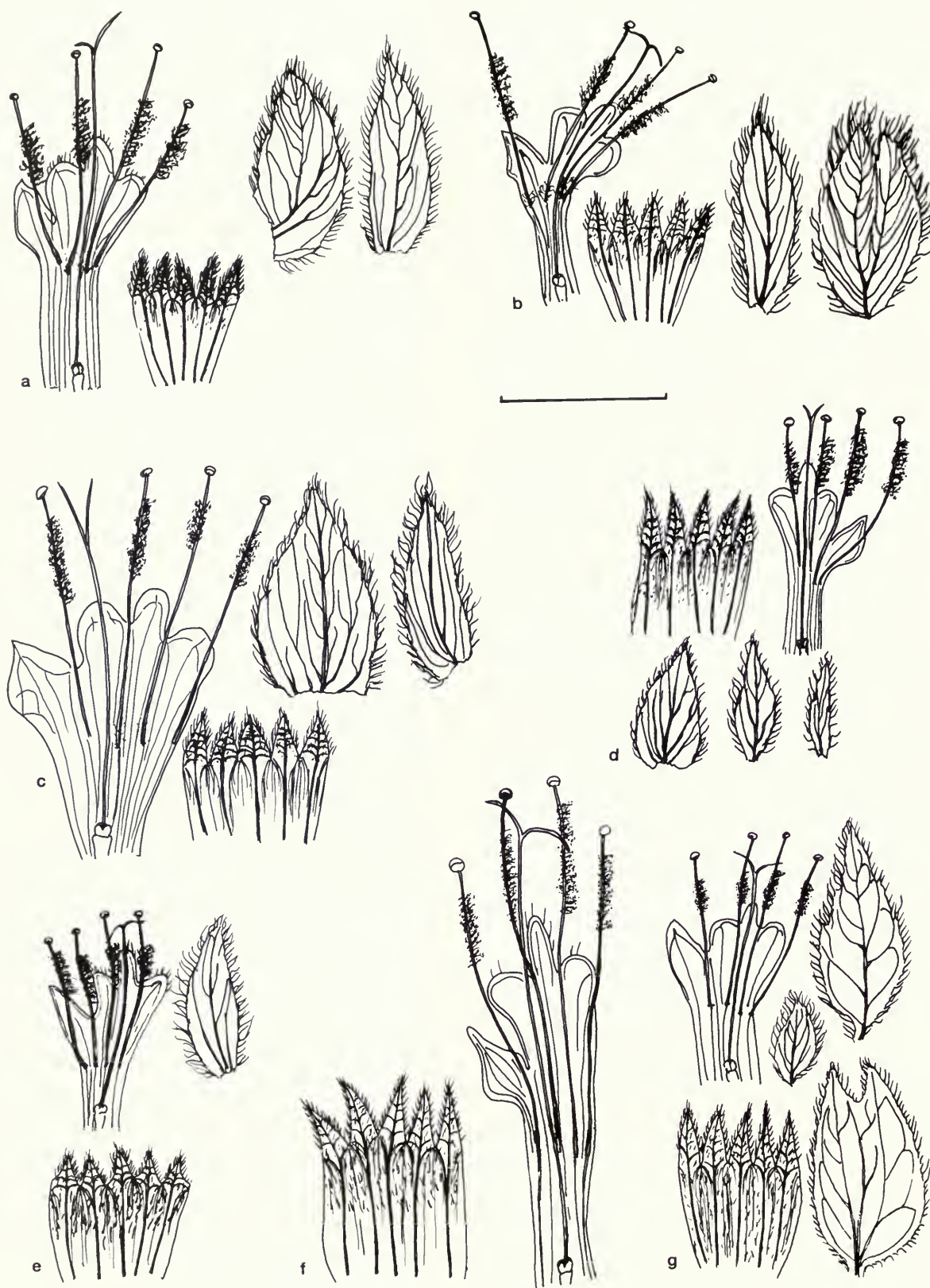
2. *Pogostemon villosus* Benth., *Labiat. gen. spec.*: 153 (1833).  
 Figs 4b, 14b.

Stem solid, terete; hairs 7-celled, *c.* 600  $\mu$ m long. Leaves ovate, 65  $\times$  30 mm, base cuneate, apex acute, margin crenate; hairs 4-celled, *c.* 400  $\mu$ m long. Petiole 15 mm long; hairs 4-celled, *c.* 270  $\mu$ m long. Inflorescence a terminal spike, *c.* 50 mm long, dense, with more than two lateral spikes; hairs 3-celled, *c.* 500  $\mu$ m long; bracts lanceolate to ovate, *c.* 6–7 mm long, some deeply cleft, two-lobed, *c.* 6  $\times$  2–3 mm, hairy. Calyx tubular-inflated, 4.0  $\times$  3.7 mm, 5-veined; teeth and upper part of tube tomentose with long hairs outside, hairy within, more densely above to sparsely below; teeth ciliate, *c.* 1.0–1.5 mm long, 0.7–0.8 mm wide at base; outer hairs 7-celled, *c.* 1600  $\mu$ m long. Corolla up to 6.2 mm long; lower lip *c.* 1.8  $\times$  1.2 mm; upper lip *c.* 1 mm across; central lobe 1.1  $\times$  0.5 mm; lobes hairy outside. Filaments inserted more or less equally, at a height of *c.* 2.7 mm in the tube; filaments *c.* 5.6–6 mm long, exerted portion *c.* 2.5 mm; many long simple hairs at middle and base of filaments, some with a few moniliform hairs. Style *c.* 7 mm long; stigma lobes *c.* 1 mm. Disc *c.* 0.8 mm long. Nutlets 4, *c.* 900  $\times$  650  $\mu$ m, oblong, punctulate.

**DISTRIBUTION.** India (Bengal) and Bangladesh.

**SPECIMENS EXAMINED.** *Hooker* s.n. (K), *Roxburgh* s.n. (BM-syntype), *Wallich* 153 (K-syntype).

This species is similar to *Pogostemon benghalensis* but has smaller flowers and a calyx tube which is hairy within.



**Fig. 4** Dissected corollas, calyces, and bracts, showing inner surface. *Pogostemon* subgenus *Pogostemon*: (a) *P. benghalensis*, (b) *P. villosus*, (c) *P. plectranthoides*, (d) *P. pubescens*, (e) *P. gardneri*, (f) *P. cristatus*, (g) *P. paniculatus*. Scale bar 5 mm.



3. ***Pogostemon plectranthoides*** Desf. in *Mém. Mus. Hist. nat. Paris* 2: 155, pl. 6 (1815).

Figs 4c, 14c.

*Mentha secunda* Roxb., *Hort. bengal.*: 44 (1814).

Shrubby plant up to 3 m high; stem solid, angular; hairs 4-celled, c. 560 µm long. Leaves ovate, 152 × 70 mm, base rounded, apex acute, margin double dentate; hairs 4-celled, c. 500 µm long. Petiole 32 mm long; hairs 5-celled, c. 500 µm long. Inflorescence a terminal spike, c. 60 mm long, dense, with more than two lateral spikes; hairs 5-celled, c. 780 µm long; bracts broadly ovate, c. 6 × 2–4 mm, hairy. Calyx tubular-inflated, 4.8 × 4.4 mm, 5-veined; with short hairs outside, only teeth hairy within; teeth ciliate, c. 1.1–1.3 mm long, 0.9–1.0 mm wide at base; outer hairs 4-celled, c. 650 µm long. Corolla up to 8 mm long, purple; lower lip c. 2.2 × 1.1 mm; upper lip c. 2.3 mm across; central lobe 1.5 mm long, 0.6 mm wide at base. Filaments purple, inserted at different heights, the lowest at a height of 3.5 mm in the tube; longest filament c. 8.0–8.6 mm long, exerted portion c. 4.1 mm; filaments more or less glabrous towards the base. Style c. 10 mm long, purple; stigma lobes c. 1.2 mm. Nutlets 4, c. 600 × 450 µm, obovoid, punctulate.

**DISTRIBUTION.** Throughout the Indian subcontinent from Tamil Nadu to Nepal and Bangladesh; absent from Sri Lanka. A very common constituent of the ground flora of *Terminalia* woodland or open bush.

**ETHNOBOTANY.** *Pogostemon plectranthoides* is one of the patchouli species, called 'Rudilo' in Nepal, 'Thekkali' in India, and used medicinally.

**SPECIMENS EXAMINED.** Barber 1353 (K), Bista 2591 (BM), Chatterjeo (K), Codrington 380 (BM), Cooper 4991 (K), Dobremez 2149 (BM), Drummond 20646 (K), Drummond 26164 (K), Drummond 26165 (K), Drummond 26166 (K), Duthie 10531 (K), Duthie 22399 (K), Falconer (K), Gamble 9007 (K), Gamble 9173 (K), Gamble 10212 (K), Gamble 13941 (K), Gamble 15843 (K), Gamble 24539 (K), Gardner 230 (BM), Lal s.n. (K), Lambert 1030 (K), Meebold 4699 (K), Mooney 673 (K), Mooney 2171 (K), Mooney 2635 (K), Nanak 20248 (K), Nanak 202647 (K), Polunin, Sykes & Williams 3784 (BM), Rich 508 (K), Ritchie 543 (K), Roxburgh s.n. (BM), Stainton 13 (BM), Stainton 5220 (BM), Stewart 1000 (K), Strachey & Winterbottom 1 (BM), Talbot 1839 (K), Thomson 527 (K), Verma 6891 (K), Wallich 1530 (K), Wood s.n. (K).

This species is similar to *Pogostemon benghalensis*. Differences are listed under that species.

4. ***Pogostemon pubescens*** Benth. in A. DC., *Prodr.* 12: 152 (1848). Figs 4d, 15a.

Stem solid, terete; hairs 3–5 celled, c. 375–1300 µm long. Leaves ovate, 70–90 × 31–67 mm, base truncate or cuneate, apex acute, margin serrate or double crenate; hairs 3–4-celled, c. 850 µm long. Petiole 20 mm long; hairs 3–5-celled, 475–850 µm long. Inflorescence a terminal spike, c. 45–58 mm long, dense, with more than two lateral spikes; hairs 3–4-celled, c. 350–480 µm long; bracts ovate-lanceolate, 3–4 × 1–2 mm, hairy. Calyx tubular-inflated, 4.2–4.5 × 3.5–4.5 mm, 5-veined; hairy outside, teeth and upper part of tube with short fine hairs within; teeth ciliate, shortest tooth c. 1.3 × 0.9 mm, longest tooth c. 1.4–1.6 × 1.0 mm; outer hairs 3-celled, 560–670 µm long. Corolla up to 5.8–6.5 mm long; lower lip c. 1.2–1.4 × 0.5–1.1 mm; upper lip c. 1.4–2.3 mm across; central lobe c. 1 mm long, 0.5–0.6 mm wide at base, hairy. Filaments inserted more or less equally at a height of 2.5 mm in the tube; longest filament c. 7 mm long, shortest

filament c. 6.5 mm long, exerted portion c. 3.2–4.4 mm; filaments glabrous towards the base. Style 7.0–9.7 mm long; stigma lobes c. 0.6–0.8 mm. Disc c. 0.6–0.9 mm long. Nutlets 4, c. 400–500 × 400–437 µm, obovoid, punctulate to reticulate-foveate.

**DISTRIBUTION.** Southeast Asia (Thailand and Vietnam).

**SPECIMENS EXAMINED.** Kerr 2384 (BM), Kerr 3113 (BM), Pételot 5297 (BM).

This species is like *Pogostemon plectranthoides* but has smaller flowers.

5. ***Pogostemon cristatus*** Hassk. in Hoenen & de Vriese, *Tijdschr. Natuurl. Gesch. Physiol.* 10: 127 (1843).

Figs 4f, 15c.

Stem weak, contracted at the base of the internodes, angular, sparsely hairy; hairs 4-celled, c. 370 µm long. Leaves ovate, 120 × 80 mm, base cuneate, apex acute, margin inciso-crenate; hairs 4-celled, c. 562 µm long, some covered with a crystalline powder. Petiole c. 60 mm long; hairs 4-celled, c. 370 µm long. Inflorescence a terminal spike, c. 100 mm long, lax below and dense above, with more than two lateral spikes; hairs 3-celled, c. 430 µm long; bracts ovate, up to 6 × 3 mm, hairy. Calyx tubular, 6 × 5 mm, 5-veined; hairy outside with long hairs and shorter hairs on veins and margin, teeth and upper part of tube hairy within; teeth ciliate, 1.7–1.9 mm long, 0.9–1.0 mm wide at base; outer hairs 4-celled, c. 750 µm long. Corolla up to 11 mm long; lower lip 2.2 × 1.5 mm; upper lip c. 2 mm across, hairy outside; central lobe c. 1.7 × 0.7 mm. Filaments attached at a height of 4 mm in the tube, c. 10–11 mm long, exerted portion c. 4 mm; filaments glabrous towards the base. Style c. 12 mm long; stigma lobes 1.3 × 1.6 mm. Disc c. 0.5 mm long. Nutlets 4, c. 900 × 700 µm, oblong, tan, with rounded patches on the surface.

**DISTRIBUTION.** Scattered throughout the East Indies including the Lesser Sunda Islands and Timor.

**SPECIMENS EXAMINED.** Kostermans & Wirawam 551 (K).

Keng (1978: 356) quoted Backer & Bakhuizen van den Brink Jr. who had noted that *Pogostemon cristatus* is closely related to *P. heyneanus*, but may be distinguished by its larger flowers.

6. ***Pogostemon gardneri*** Hook.f., *Fl. Brit. India* 4: 632 (1885). Figs 4e, 15b.

Stem erect, bluntly 4-angled, reddish brown, villous; hairs 5-celled, c. 1500 µm long. Leaves ovate, 80 × 50 mm, base cuneate, apex acuminate, margin inciso-crenate or sharply double crenate; hairs 5-celled, c. 1300 µm long. Petiole c. 30 mm long; hairs 6-celled, c. 1300 µm long. Inflorescence a terminal spike, c. 80 mm long, dense, with two lateral spikes, flowers in whorls; hairs on stalk 5-celled, c. 1250 µm long; bracts ovate, up to 6 × 1.5 mm, hairy. Calyx tubular-inflated, 4 × 4.5 mm, 5-veined; outside with relatively few, stout hairs, upper half of tube hairy within with long fine hairs, the teeth glabrous within; teeth c. 0.9 × 0.9 mm; outer hairs 10-celled, c. 1750 µm long. Corolla up to 5.5 mm long; lower lip 1.5 × 1 mm; upper lip c. 1.7 mm across; central lobe c. 1 × 0.5 mm. Filaments all inserted at a height of 2 mm in the tube, c. 4.3–4.7 mm long; exerted portion c. 1.2 mm; filaments glabrous at base. Style c. 5.5 mm long; stigma lobes 0.5 mm. Disc c. 0.8 mm long. Nutlets 4; c. 1000 × 900 µm, ellipsoid to ellipsoid-oblong, dark brown, punctulate.

**DISTRIBUTION.** Western India in the vicinity of Travancore.

**SPECIMENS EXAMINED.** Gardner 1847 (K-syntype), Gardner 2122 (CAL-syntype), Venkabo 3229 (K), Wight 1913 (K).



7. *Pogostemon paniculatus* (Willd.) Benth. in Wall., *Pl. asiat. rar.* 1: 30 (1830).

Figs 4g, 16a.

*Hyssopus cristatus* Lam., *Encycl.* 3: 187 (1789), non *Elsholtzia cristatus* (Willd.) Willd. (1800), non *Pogostemon cristatus* Hassk. (1843).

*Elsholtzia paniculata* Willd., *Sp. pl.* 3: 59 (1800).

Stem solid, angular; hairs 4-celled, c. 750 µm long. Leaves ovate, 106 × 57 mm, base cuneate, apex acute, margin double dentate; hairs 3-celled, c. 600 µm long. Petiole c. 18 mm long; hairs 5-celled, c. 800 µm long. Inflorescence a terminal spike, c. 40 mm long, secund, lax below and dense above, with more than two lateral spikes; hairs c. 4-celled, c. 750 µm long; bracts broad, toothed or entire, up to 7 × 3.5 mm. Calyx infundibular, 4.0 × 3.2 mm, 5-veined; hairy outside especially on the teeth, teeth and upper tube hairy within; teeth ciliate, c. 0.9–1.0 mm long, c. 0.4–0.7 mm wide at base; outer hairs 5-celled, c. 1100 µm long. Corolla up to 5.9 mm long; lower lip c. 1 × 1 mm; upper lip c. 1.5 mm across, hairy; central lobe c. 0.9 × 0.5 mm. Filaments inserted at different heights, the lowest at a height of 2.5 mm in the tube; filaments c. 4.5–5.2 mm long, exerted portion c. 1.8 mm; filaments glabrous towards the base. Style c. 6.3 mm long; stigma lobes c. 0.7–0.8 mm. Disc c. 0.8 mm long. Nutlets 4, c. 500 × 400 µm, ellipsoid to ellipsoid-oblong, punctulate.

DISTRIBUTION. India (Madras, Bombay, Nilgiri, Kannothe, Kunda Hills, Travancore, Mysore, Malabar, Carnatic, Salem, Namakkal Dist.) and Thailand.

SPECIMENS EXAMINED. *Beddome* s.n. (BM), *Fernandes* 1786 (K), *Gamble* 9576 (K), *Gamble* 11987 (K), *Gamble* 15566 (K), *Hooker & Thomson* s.n. (K), *Kerr* 17609 (BM), *Miquel* 249 (K), *Perumal* 21757 (K), *Rungachari* s.n. (K), *Saldanha* 15771 (K), *Wallich* 1561 (K-neotype), *Wight* 2119 (K), *Wight* 2126 (BM, K), *Wight* 2529 (K).

8. *Pogostemon purpurascens* Dalzell in *Hooker's J. Bot.* 2: 337 (1850).

Figs 5a, 16b.

Stem solid, terete; hairs 13-celled, c. 1500 µm long. Leaves ovate, 100 × 68 mm, base cuneate, apex acute, margin double dentate; hairs 8-celled, c. 1700 µm long. Petiole 25 mm long; hairs 7-celled, 1600 µm long. Inflorescence a single terminal spike, 80 mm long, dense; hairs 4-celled, c. 860 µm long; bracts ovate to palmate, obscurely or markedly toothed, up to 5–6 × 1.5–5 mm, hairy. Calyx tubular, 6.0 × 4.5 mm, 5-veined; hairy outside with long hairs, teeth and tube less densely hairy within; teeth ciliate, c. 1.3–2.2 mm long, c. 0.7–1.1 mm wide at base; outer hairs 4-celled, c. 930 µm long. Corolla up to 5.5 mm long; lower lip c. 1.1 × 1 mm; upper lip c. 1 mm across; central lobe c. 1 × 0.4 mm, sparsely hairy. Filaments all inserted at a height of 2.4 mm in the tube, c. 5.7–7.0 mm long, exerted portion c. 3.9 mm; filaments glabrous towards the base. Style c. 7.2 mm long; stigma lobes c. 2.0–2.5 mm. Disc c. 0.5 mm long. Nutlets 4, c. 500 × 400 µm, ellipsoid to ellipsoid-oblong, reticulate with punctate walls.

DISTRIBUTION. Throughout India (Assam, Himalaya (West), Concan, Manipur, Bombay).

ETHNOBOTANY. *Pogostemon purpurascens* contains an astringent resin, an alkaloid, a yellow varnish of a slightly bitter taste and mouse-like odour of trimethylamine, and a volatile oil with an odour similar to cedar wood. The stem and leaves are a stimulant and styptic. Fresh leaves are used to clean wounds and provide healthy granulation. In parts of India the roots are reputed to be a remedy for snake bite.

SPECIMENS EXAMINED. *Dalzell* 5747 (K-syntype), *Duthie* 10537 (K), *Hooker* 2337 (K-syntype), *Stocks* s.n. (BM), *Watt* 5078 (K), *Wight* s.n. (K).

9. *Pogostemon cablin* (Blanco) Benth. in A. DC., *Prodr.* 12: 156 (1848).

Figs 5b, 16c.

*Mentha cablin* Blanco, *Fl. Filip.*: 473 (1837).

*M. auricularia* Blanco, *Fl. Filip.* ed. 2: 473 (1845), non L. (1767).

*Pogostemon patchouly* Pellet. in *Mém. Soc. Sci. phys. Orléans* 5: 277, t. 7 (1845).

*P. suavis* Ten. in Parl., *G. Bot. ital.* 2: 56 (1847), pro parte.

Stem solid, angular; hairs 4-celled, 680 µm long. Leaves ovate, c. 80 × 60 mm, base cuneate, apex obtuse, margin dentate; hairs 5-celled, c. 1250 µm long. Petiole c. 26 mm long; hairs 5-celled, c. 900 µm long. Inflorescence a terminal spike, c. 45 mm long, lax below and dense above, with more than two lateral spikes; hairs 3-celled, c. 150 µm long; bracts ovate to lanceolate, entire or toothed, 4–9 × 0.7–4.0 mm. Calyx tubular-inflated, c. 4.5 × 2.8 mm, 5-veined; densely hairy outside, teeth and upper part of tube more or less glabrous within, with only a few scattered hairs; teeth ciliate, c. 1.8–1.9 mm long, c. 0.6 mm wide at base; outer hairs 3-celled, c. 400 µm long. Corolla up to 6.2 mm long, mauve; lower lip c. 1.4 × 0.9 mm; upper lip c. 1.1 mm across, slightly hairy; central lobe 1.3 × 0.4 mm. Filaments all inserted at a height of 2 mm in the tube, c. 5.8–6.0 mm long, exerted portion c. 1.8 mm; filaments glabrous towards the base. Style c. 5.8 mm long; stigma lobes 1.4–1.9 mm. Disc 0.8 mm long. Nutlets 4, c. 800 × 600 µm, ellipsoid to ellipsoid-oblong, reticulate-foveate.

DISTRIBUTION. Widespread in the tropics including Thailand, Fiji, Philippines (Luzon), Sumatera, India, Mauritius, and introduced to Florida. This is one of the species which yields patchouli oil and it has evidently been introduced into many places. According to Merrill (1944) it is commonly found in cultivation in the Philippines, although not on a commercial scale. It flowers in the Philippines but rarely elsewhere. This fact does not support the suggestion by Merrill (1912) that it is not truly native in the Philippines.

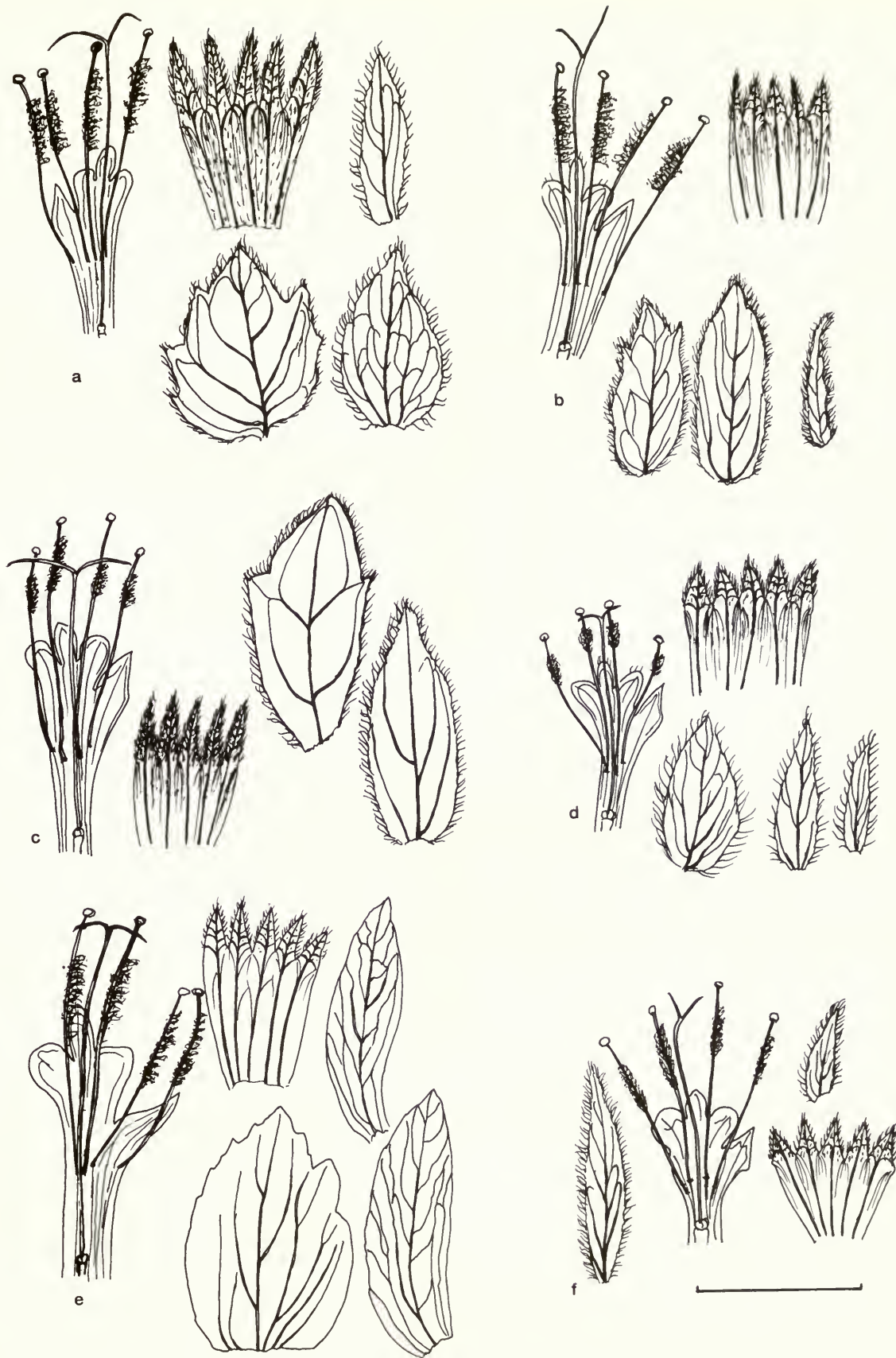
ETHNOBOTANY. The leaves and stems of *Pogostemon cablin* are employed as an insecticide against cockroaches, moths, and other insects and also as a repellent for leeches. In the Philippines the crushed leaves are sometimes used for washing. Leaves are also added to baths for their antirheumatic property and an infusion of fresh leaves is taken internally to allay painful menstruation. The inflorescence of *P. cablin* is sold in Goa to dress the hair of women.

SPECIMENS EXAMINED. *Alston* 14403 (K), *Clemens* s.n. (BM), *Degener & Ordonez* 14018 (K), *Dupont* 1769/23 (K-cult.), *Kerr* 17069 (K), *Merrill* 112 (BM, K), *Plowman* 13285 (K-cult.), *Reillo* 19292 (BM).

10. *Pogostemon nepetoides* Stapf in *Bull. misc. Inf. R. bot. Gdns. Kew* [1908]: 116 (1908).

Figs 5c, 17a.

Stem solid, angular; hairs 4-celled, c. 980 µm long. Leaves ovate, 91 × 64 µm, base truncate, apex obtuse, margin inciso-serrate; hairs 4-celled, c. 1200 µm long. Petiole 34 mm long; hairs 4-celled, c. 1100 µm long. Inflorescence a terminal spike, c. 105 mm long, lax below and dense above, with more than two lateral spikes; hairs 3-celled, c. 360 µm long; bracts ovate to deeply cleft, three-lobed or toothed, 4–8 mm long, hairy. Calyx tubular, 4.6 × 3.6 mm, 5-veined; teeth and upper part of tube with long hairs outside, within the teeth hairy, the tube more or less glabrous; teeth ciliate, 1.8–2.0 mm long, c. 0.7 mm



**Fig. 5** Dissected corollas, calyces and bracts, showing inner surface. *Pogostemon* subgenus *Pogostemon*: (a) *P. purpurascens*, (b) *P. cablin*, (c) *P. nepetoides*, (d) *P. heyneanus*, (e) *P. nelsonii*, (f) *P. glaber*. Scale bar 5 mm.



wide at base; outer hairs 2-celled, c. 560 µm long. Corolla up to 6.2 mm long; lower lip c. 1.6 × 1 mm; upper lip c. 1.6 mm across; central lobe 1.2 × 0.5 mm, with a few hairs. Filaments inserted at slightly different heights, the lowest at a height of 2.6 mm in the tube; filaments c. 5.3–6.8 mm long, exerted portion c. 3.2 mm; filaments glabrous towards the base. Style c. 7.2 mm long; stigma lobes 1.9–2.1 mm. Disc c. 0.9 mm long. Nutlets 4, c. 600 × 400 µm, ellipsoid to ellipsoid-oblong, punctulate.

**DISTRIBUTION.** The Philippines (Luzon).

**SPECIMENS EXAMINED.** *Micholitz* s.n. (K-holotype), *Ramos* 22432 (BM).

11. ***Pogostemon heyneanus*** Benth. in Wall., *Pl. asiat. rar.* 1: 31 (1830).

Figs 5d, 17b.

*Origanum indicum* Roth, *Nov. pl. sp.*: 265 (1821).

*Pogostemon patchouly* sensu Hook.f., *Fl. Brit. India* 4: 633 (1885), non Pelletier (1845).

*P. suavis* Ten. in Parl., *G. Bot. ital.* 2: 56 (1847), pro parte.

Stem solid, angular; hairs 4-celled, c. 500 µm long. Leaves ovate, 85 × 45 mm, base cuneate, apex acuminate, margin double dentate; hairs 4-celled, c. 460 µm long. Petiole 32 mm long; hairs 4-celled, c. 350 µm long. Inflorescence a terminal spike, c. 70 mm long, lax below, dense above, with more than two lateral spikes; hairs 4-celled, 350 µm long; bracts ovate to lanceolate, entire or indistinctly toothed, 3.0–5.0 × 0.8–3.0 mm. Calyx tubular, 4.3 × 3.1 mm, 5-veined; teeth and upper part of tube hairy within, hairy throughout outside; teeth ciliate, c. 1.2–1.4 mm long, 0.4–0.6 mm wide at base; outer hairs 3-celled, c. 312 µm long. Corolla up to 4.8 mm long; lower lip c. 1.6 × 0.9 mm; upper lip c. 1.5 mm across; central lobe 0.9 × 0.3 mm, hairy. Filaments inserted more or less equally, at a height of 1.7 mm in the tube, c. 3.7–4.3 mm long, exerted portion c. 1.2 mm; filaments glabrous towards the base. Style c. 5.6 mm long; stigma lobes c. 0.6–0.7 mm. Disc c. 0.7 mm long. Nutlets 4, c. 500 × 400 µm, orbicular, reticulate and punctate.

**DISTRIBUTION.** Widespread in southern Asia from Sri Lanka, India (Bombay, Mysore, Tinnually Ghats) to Indonesia (Java, Sumatera). Perhaps introduced into some areas like the Seychelles, although also found beside pathways through the jungle.

**ETHNOBOTANY.** One of the most important sources of patchouli oil which is extracted from the dried tops. It is very rich in volatile terpenoids. The dried leaves and tops of plants are sold in the markets of India and the Seychelles. The leaves of *Pogostemon heyneanus* (var. 'Patch-Pat') are used medicinally for stomach and skin diseases and in Malaysia to treat coughs and asthma. A decoction made from the roots is sometimes administered for dropsy. Hartwell (1982) listed *P. heyneanus* as a possible anti-cancer medicine. In different parts of India the leaves are used as a diuretic and carminative agent and they are generally given with the seeds of *Ocimum tenuiflorum* (vernacular name 'Tulsi') in cases of scanty urine and biliousness.

**SPECIMENS EXAMINED.** *Barber* 2218 (K), *Beddome* s.n. (BM), *Farnandas* 1886 (K), *Gardner* 660 (BM, K), *Johnson* 130 (K), *Kuntze* 5258 (K), *Macrae* 254 (BM, K), *Macrae* 1532 (K-type), *Macrae* 1733 (K), *Ridley* 14300a (BM), *Robinson & Kloss* 88 (BM), *Simpson* 9513 (BM), *Wallich* 231 (K), *Wallich* 1830 (K), *Wallich* 1891 (BM), *Wallich* 2131 (BM), *Wight* 2120 (K).

12. ***Pogostemon nelsonii*** Doan in Humbert, *Fl. gen. Indo-Chine* 4: 975 (1936).

Figs 5e, 17c.

Stem solid, terete, glabrous. Leaves ovate, 104 × 68 mm, base cuneate, apex acute, margin double dentate, lamina glabrous. Petiole 14 mm long, glabrous. Inflorescence a terminal spike, c. 43 mm long, with two lateral spikes, all spikes dense, glabrous; bracts ovate, entire or toothed, up to 8–9 × 2–6 mm, glabrous. Calyx tubular, 5.0 × 3.8 mm, 5-veined; with very short hairs outside, glabrous within; teeth ciliate, 1.2–1.4 mm long, 0.7–0.8 mm wide at base. Corolla up to 8.2 mm long; lower lip c. 2.3 × 1 mm; upper lip c. 2 mm across; central lobe 1.5 × 0.7 mm, with a few hairs. Filaments inserted at different heights, the lowest at a height of 3.5 mm in the tube; filaments c. 6.5–7.5 mm long, exerted portion c. 2.8 mm; moniliform hairs poorly developed, filaments glabrous towards the base. Style c. 10.2 mm long; stigma lobes c. 1.1–1.3 mm. Disc c. 0.6 mm long. Nutlets 4, c. 600 × 300 µm, oblong, foveolate.

**DISTRIBUTION.** Southern India (Kerala).

**SPECIMENS EXAMINED.** *Nelson* s.n. (BM).

13. ***Pogostemon glaber*** Benth. in Wall., *Pl. asiat. rar.* 1: 31 (1830). Figs 5f, 18a.

*Perilla polystachya* D. Don, *Prodr. fl. nepal.*: 115 (1825).

Bush up to 2 m high; stem dark red-purple; hairs 3-celled, c. 250 µm long. Leaves ovate, 150 × 97 mm, base cuneate, apex acuminate, margin double dentate; hairs 3-celled, c. 300 µm long. Petiole 40 mm long, glabrous. Inflorescence a terminal spike, c. 55 mm long, dense, with two lateral spikes; hairs 3-celled, c. 230 µm long; bracts lanceolate, 3.0–7.0 × 0.8–1.3 mm, hairy. Calyx tubular-inflated, c. 3.3 × 3.5 mm, 5-veined; outside the tube sparsely hairy and the teeth glabrous, the teeth hairy within; teeth ciliate, c. 0.9–1.1 mm long, c. 0.6–0.8 mm wide at base. Corolla up to 4.7 mm long, pale whitish pink or light mauve; lower lip c. 1.2 × 1 mm; upper lip c. 1.6 mm across, hairy; central lobe 0.9 × 0.6 mm. Filaments inserted at different heights, the lowest at a height of 2 mm in the tube; filaments c. 4.7–5.8 mm long, exerted portion c. 3.1 mm; filaments glabrous towards the base. Style 6.5 mm long; stigma lobes 0.9–1 mm. Disc c. 0.7 mm long. Nutlets 4, c. 700 × 600 µm, orbicular, punctulate.

**DISTRIBUTION.** Widespread from northwestern India and Nepal to Yunnan and Thailand. In Thailand it is found in mixed-oak forest, in shade, above 1000 m, and in Nepal it is a common weed on cut-over slopes.

**ETHNOBOTANY.** The leaves ground in water are used to relieve the pain and itching of mosquito bites.

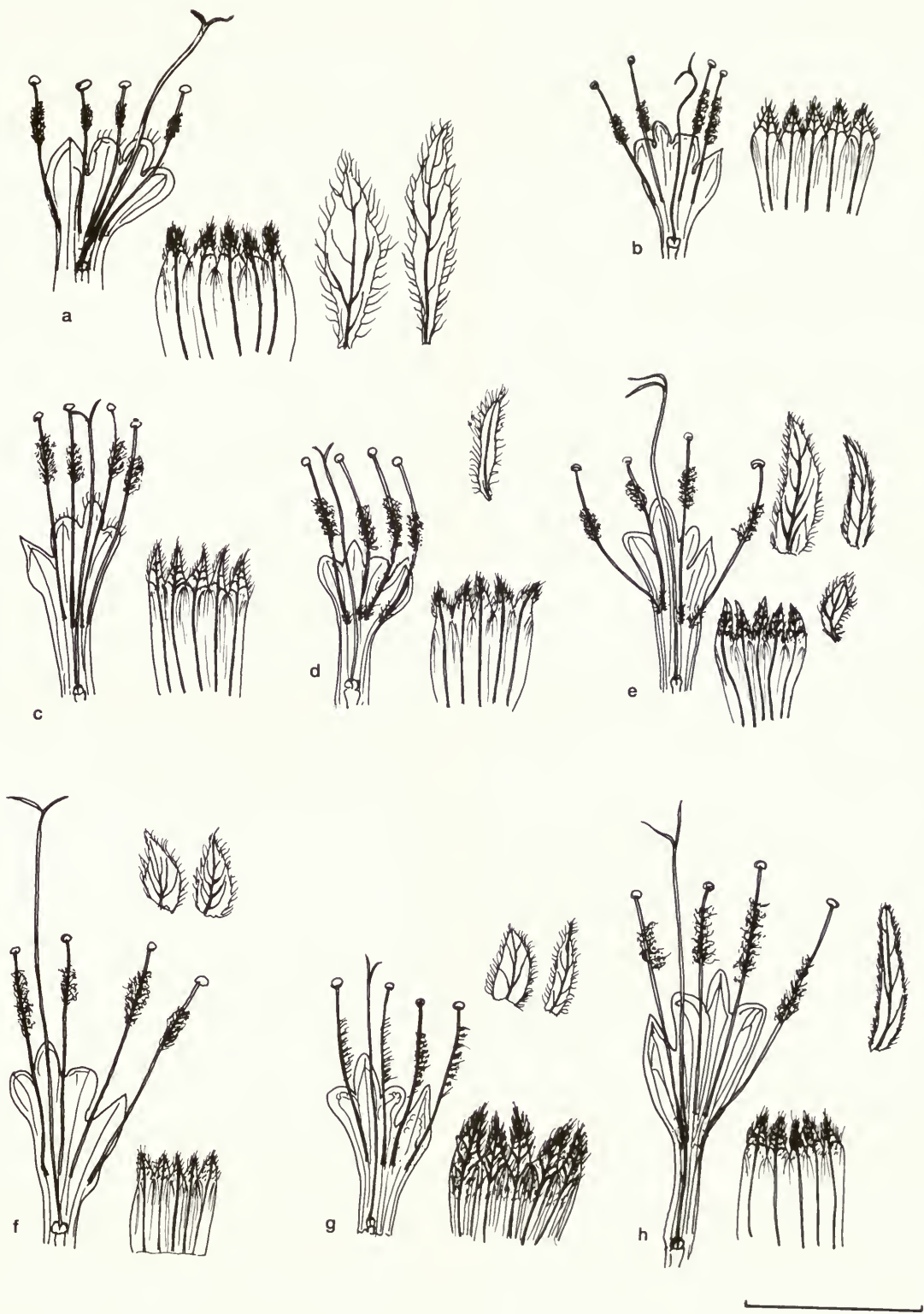
**SPECIMENS EXAMINED.** *Dawson* 262 (BM), *Dobremez* 739 (BM), *Flatt* 161 (BM), *Forrest* 16161 (BM, K), *Gamble* 3846 (K), *Henry* 10418 (K), *Henry* 11487 (K), *Henry* 12832 (K), H.I. 1533 (K-syntypes), *Kerr* 1684 (BM), *Kerr* 2907 (BM), *Kerr* 3922 (BM), *Kerr* 4737 (BM), *McClure* 8454 (K), *Nicolson* 2941 (BM), *Schilling* 749 (K).

14. ***Pogostemon hispidus*** Prain in Bull. misc. Inf. R. bot. Gdns, Kew [1908]: 254 (1908).

Figs 6a, 18b.

Stem solid, angular; hairs 6-celled, c. 720 µm long. Leaves ovate, c. 118 × 87 mm, base cuneate, apex acute, margin double dentate; hairs 4-celled, c. 770 µm long. Petiole 46 mm long; hairs 5-celled, 870 µm long. Inflorescence a terminal spike, c. 70 mm long, dense, with two lateral spikes; hairs 5-celled, c. 780 µm long; bracts ovate or lanceolate, indistinctly toothed, 5.0–7.0 × 1.0–1.8 mm, hairy. Calyx tubular-inflated, 4.0 × 3.5 mm, 5-veined; tube more or less glabrous within, the teeth very hairy inside at tip, more sparsely below, the





**Fig. 6** Dissected corollas, calyces and bracts, showing inner surface. *Pogostemon* subgenus *Pogostemon*: (a) *P. hispidus*, (b) *P. wattii*, (c) *P. championii*, (d) *P. formosanus*, (e) *P. elsholtzioides*, (f) *P. tuberosus*, (g) *P. griffithii*, (h) *P. dielsianus*. Scale bar 5 mm.

outside with relatively few long hairs throughout; teeth ciliate, c. 0.8–1.0 mm long, 0.5–0.9 mm wide at base; outer hairs 3-celled, c. 680 µm long. Corolla up to 4.5 mm long; lower lip c. 1.2 × 1.2 mm; upper lip c. 1.9 mm across; central lobe c. 0.9 × 0.8 mm, with a few hairs. Filaments inserted at different heights, the lowest at a height of 2 mm in the tube; filaments c. 3.7–4 mm long, exerted portion c. 1.5 mm; filaments glabrous towards the base. Style c. 8.5 mm long; stigma lobes c. 0.6 mm. Disc c. 0.4 mm long. Nutlets 4, c. 700 × 600 µm, orbicular, foveate.

DISTRIBUTION. Thailand to Bangladesh. In forest areas.

SPECIMENS EXAMINED. *Jenkins* in Herb. Hooker (K-paratype), *Kerr* 6631 (BM).

15. *Pogostemon wattii* C.B. Clarke in *J. Linn. Soc.* **25**: 59 (1889). Figs 6b, 18c.

*Pogostemon battakianus* Ridl. in *J. Asiat. Soc. Mal.* **1**: 85 (1923).

Stem solid, terete; hairs 5-celled, c. 800 µm. Leaves ovate, c. 75 × 45 mm, base truncate, apex acute, margin double dentate; hairs 5-celled, c. 1000 µm long. Petiole c. 20 mm long; hairs 5-celled, c. 0.8 mm long. Inflorescence a terminal spike, c. 7 cm long, dense, with two or more lateral spikes; hairs 8-celled, c. 1000 µm long. Calyx tubular-inflated, c. 3 × 3.5 mm, 5-veined; sparsely hairy or glabrous outside, teeth and upper part of tube hairy within; teeth ciliate, c. 0.8–1 mm long, c. 0.5–0.7 mm wide at base; outer hairs 3-celled, c. 350 µm long. Corolla up to 4 mm long; lower lip c. 1 × 1 mm; upper lip c. 1.8 mm across; central lobe c. 0.8 mm long, 0.6 mm wide at base. Filaments all inserted at a height of 1.7 mm in the tube, c. 3.5–4 mm long, exerted portion c. 0.5 mm; filaments all glabrous at the base. Style 5.5 mm long; stigma lobes c. 0.5 mm. Disc c. 0.4 mm long. Nutlets 4; c. 430 × 360 µm, ovoid, reticulate-foveate.

DISTRIBUTION. India (western Assam).

SPECIMENS EXAMINED. *Clarke* 41719 (K-holotype).

The name *Pogostemon wattii* C.B. Clarke has been a source of confusion. Prain (1891) included *P. wattii* in 'Some additional species of Labiatae', remarking that it was very distinct. Later he described *Eurysolen gracilis*, citing the same specimens he had previously listed under *Pogostemon wattii*. It is doubtful if he saw the holotype of *P. wattii* which is very different. Use of Prain's account has resulted in the misidentification of many specimens of *Eurysolen gracilis* as *Pogostemon wattii*.

16. *Pogostemon championii* Prain in *Bull. misc. Inf. R. bot. Gdns, Kew* [1908]: 254 (1908). Figs 6c, 19a.

Stem erect, solid, 4-angled, glabrous below, hairy towards upper parts; hairs 5-celled, c. 500 µm long. Leaves ovate, up to 110 × 60 mm, base cuneate, apex acuminate, margin double crenate; hairs 4-celled, c. 550 µm long. Petiole up to 40 mm long; hairs 5-celled, c. 500 µm long. Inflorescence a terminal terminal spike, c. 40 mm long, first whorl of flowers separated from the rest, lateral spikes with single whorl of flowers; hairs on stalk 4-celled, c. 400 µm long. Calyx tubular-inflated, c. 4.2 × 3.2 mm, 5-veined; hairy outside especially on veins, glabrous within; teeth ciliate, 1.1–1.3 mm long; outer hairs 4-celled, c. 550 µm long. Corolla up to 5.5 mm long; lower lip 1.5 × 1 mm; upper lip 1.2 mm across, hairy; central lobe c. 1 × 0.5 mm. Filaments inserted at different heights, the lowest two at a height of 2.5 mm in the tube; filaments c. 5–6 mm long, exerted portion c. 2.5 mm; filaments glabrous at the base. Style c. 7.5 mm long; stigma lobes c. 0.7 mm. Disc c. 0.8 mm

long. Nutlets 4, c. 780 × 650 µm, orbicular, black, shiny, reticulate-foveate.

DISTRIBUTION. Hong Kong.

SPECIMENS EXAMINED. *Champion* 339 (K-holotype), *Hu* 12421 (K).

17. *Pogostemon formosanus* Oliver in *Hooker's Icon. Pl.* **25**: pl. 2440 (1896).

Figs 6d, 19b.

Stem solid, terete, sparsely hairy; hairs 3-celled with longer apical cell, c. 250 µm long. Leaves ovate, 11 × 6.5 mm, base cuneate, apex acuminate, margin inciso-serrate, abaxial surface of lamina glabrous, adaxial surface sparsely hairy; hairs 2-celled, c. 250 µm long. Petiole 45 mm long, weak; hairs 2-celled, c. 160 µm long. Inflorescence a terminal spike, c. 45 mm long, lax, with three or more lateral spikes; hairs 2-celled, c. 300 µm long; bracts small, lanceolate, c. 3.5 × 0.7 mm, hairy. Calyx campanulate, angular, c. 4 × 3.6 mm, 5-veined; puberulent outside, mostly on the veins, teeth hairy within near tip with a row of hairs slightly inside the margin, otherwise glabrous; teeth c. 1.3–1.5 × c. 0.6–0.8 mm; hairs 2-celled, c. 250 µm long. Corolla c. 4.5 mm long; lower lip c. 1.2 × 0.9 mm, few hairs at tip; upper lip c. 1.5 mm across, hairy outside; central lobe c. 1.2 × 9 mm. Filaments all inserted at a height of 2.4 mm in the tube, c. 2.5–2.8 mm long, exerted portion c. 0.7 mm; filaments hairy towards the base, two upper stamens more so than lower two. Style c. 6 mm long; stigma lobes c. 0.5 mm. Disc c. 0.5 mm long. Nutlets 4, c. 700 × 600 µm, obovoid, dark brown, reticulate-foveate.

DISTRIBUTION. Taiwan.

SPECIMENS EXAMINED. *Henry* 1178 (CAL, K).

18. *Pogostemon elsholtzioides* Benth. in A. DC., *Prodr.* **12**: 153 (1848).

Figs 6e, 19c.

Bushy shrub up to 2 m high; stem solid, angular; hairs 4-celled, c. 220 µm long. Leaves lanceolate, 120 × 28 mm, base cuneate, apex acuminate, margin serrate; hairs 4-celled, 225 µm long. Petiole 0.6 mm long; hairs 4-celled, c. 225 µm long. Inflorescence a terminal spike, c. 50 mm long, dense, with more than two lateral spikes; hairs 3-celled, c. 170 µm long; bracts ovate or lanceolate, 1.5–5.0 × 0.6–1.4 mm. Calyx tubular, 4.2 × 3.0 mm, 5-veined; teeth hairy within, hairy outside with many white hairs and with small tufts of hair at sinuses of teeth; teeth not ciliate, c. 1.0–1.1 mm long, c. 0.5–0.7 mm wide at base; outer hairs 3-celled, c. 160 µm long. Corolla up to 4.5 mm long, purple; lower lip c. 1 × 0.7 mm; upper lip c. 1.7 mm across, glabrous; central lobe 0.7 × 0.9 mm. Filaments pink, inserted at different heights, the lowest at a height of 2 mm in the tube; filaments c. 4.5–5 mm long, exerted portion c. 2.5 mm; filaments with a few hairs, more or less equally hairy towards the base. Style 5.8 mm long; stigma lobes c. 0.7 mm long. Disc c. 0.5 mm long. Nutlets 4, c. 1700 × 600 µm, lanceolate, ruminate.

DISTRIBUTION. Widespread in the Himalayas: Bhutan, India (Khasia, Naga Hills). Common in secondary growth, waste places, along roadsides, at the edge of forests, on cultivated land, and around villages.

SPECIMENS EXAMINED. *Bar* 24 (K), *Bar* 6649 (K), *Clarke* 41505 (K), *Clarke* 42819 (BM), *Griffith* 202 (BM, K-syntypes), *Griffith* 3962 (K-syntype), *Kingdon-Ward* 6346 (K), *Kingdon-Ward* 6449 (K), *Kingdon-Ward* 7841 (K), *Kingdon-Ward* 11293 (BM, K), *Kingdon-Ward* 14234 (BM), *Kingdon-Ward* 18372 (BM), *Kingdon-Ward* 18894 (BM), *Kingdon-Ward* 20274 (BM), *Ludlow*, *Sherriff* &



Elliot 12255 (BM), Meebold 72027 (K), Simon s.n. (K), Watt 6656 (K).

19. ***Pogostemon tuberculosus*** Benth. in Wall., *Pl. asiat. rar.* 1: 31 (1830).

Figs 6f, 20a.

Shrub 2–3 m high; stem solid, terete; hairs stellate, central hair 2-celled, c. 110  $\mu$ m long, radiating hairs 1-celled. Leaves ovate, 110  $\times$  65 mm, base cuneate, apex acute, margin crenate; hairs similar to those of stem. Petiole 30 mm long; hairs similar to those of stem. Inflorescence with more than two laterals verticillasters; verticillasters c. 200–300 mm long; verticils many flowered, very dense, widely spaced in inflorescence; bracts small, ovate, 2.5  $\times$  1.0 mm, hairy. Calyx tubular-inflated, 3.0  $\times$  3.0 mm, 5-veined; with many stellate hairs outside, teeth hairy within; teeth ciliate, c. 0.9–1.0 mm long, c. 0.4–0.6 mm wide at base; outer hairs with central hair 3-celled, c. 370  $\mu$ m long, lateral hairs 1-celled. Corolla up to 7.2 mm long, pale mauve; lower lip c. 1.5  $\times$  1 mm; upper lip c. 2 mm across, glabrous; central lobe c. 1.3  $\times$  0.8 mm. Filaments all inserted at a height of 2.4 mm in the tube, deep purplish, c. 7.4–8.9 mm long, exerted portion c. 4.1 mm; filaments glabrous at the base, anthers fawn. Style deep purplish, 11.5 mm long; stigma lobes c. 12 mm. Disc c. 0.7 mm long. Nutlets 4, c. 800  $\times$  600  $\mu$ m, oblong, granulose.

DISTRIBUTION. Eastern Himalayas (Bhutan, Nepal, Kaluimphoong, Assam, Darjiling). Among thick undergrowth in broad-leaved forest.

SPECIMENS EXAMINED. Clarke 26368B (K), Gamble 3843A (K), Gamble 3847A (K), Gamble 7515 (K), Haines 1041 (K), Hooker s.n. (K), Ludlow, Sherriff & Taylor 6759 (BM, E), Treutler 1194 (K), Wallich s.n. (K-type).

20. ***Pogostemon griffithii*** Prain in *Bull. misc. Inf. R. bot. Gdns, Kew* [1908]: 181 (1908).

Figs 6g, 20b.

*Pogostemon griffithii* var. *latifolius* C.Y. Wu & Y.C. Huang, *Fl. Yunnanica* 1: 744 (1977).

Stem solid, terete; hairs 3-celled, 250  $\mu$ m long. Leaves 2, lanceolate, 95  $\times$  25 mm, base cuneate, apex acute, margin dentate; hairs 3-celled, c. 250  $\mu$ m long. Petiole c. 10 mm long; hairs 3-celled, c. 250  $\mu$ m long. Inflorescence a terminal spike, c. 50 mm long, dense, with two lateral spikes; hairs 3-celled, c. 250  $\mu$ m long; bracts ovate or lanceolate, 2.0–3.0  $\times$  0.5–1.0 mm, hairy. Calyx campanulate, 3.3  $\times$  3.5 mm, 5-veined; upper part of tube and teeth hairy within. hairy throughout outside; teeth ciliate, c. 1.1–1.4 mm long, 0.5–0.7 mm wide at base, incurved in fruit; outer hairs 3-celled, c. 375  $\mu$ m long. Corolla up to 5 mm long; lower lip c. 1.5  $\times$  1 mm; upper lip c. 1.2 mm across; central lobe c. 1.3  $\times$  0.7 mm. Filaments all inserted at a height of 2 mm in the tube, c. 4.7–5.2 mm long, exerted portion c. 2.2 mm; filaments more or less glabrous towards the base. Style c. 5.5 mm long; stigma lobes c. 1.2 mm. Disc c. 0.4 mm long. Nutlets 4, c. 800  $\times$  600  $\mu$ m, oblong, ruminant.

DISTRIBUTION. Burma.

SPECIMENS EXAMINED. Griffith 3962 (K-holotype).

The type specimen of *Pogostemon elsholtzioides* is also Griffith 3962, although the collection is of a different plant from a different locality.

21. ***Pogostemon dielsianus*** Dunn in *Notes R. bot. Gdn Edinb.* 8: 159 (1913).

Figs 6h, 20c.

Spreading shrub up to 3 m; stem solid, angular; hairs 3-celled, c. 100  $\mu$ m long. Leaves linear-lanceolate, 120  $\times$  32 mm, base cuneate, apex acuminate, margin dentate, lamina more or less glabrous above, with reddish 3-celled hairs below, c. 150  $\mu$ m long. Petiole c. 7 mm long; hairs 3-celled, c. 125  $\mu$ m long. Inflorescence a terminal spike, c. 45 mm long, dense, with more than two lateral spikes; hairs 3-celled, c. 180  $\mu$ m long; bracts lanceolate, c. 4.5  $\times$  0.8 mm, hairy. Calyx tubular, c. 4.4  $\times$  3.0 mm, 5-veined; teeth hairy within with long fine hairs, a row of hairs slightly inside the margin, outside with glands and a dense felt of short hairs; teeth c. 1.2  $\times$  0.7 mm; outer hairs 3-celled, c. 125  $\mu$ m long. Corolla up to 7.5 mm long, rose-red; lower lip 1.4  $\times$  1 mm; upper lip c. 1.8 mm across; central lobe c. 1.2  $\times$  1 mm. Filaments inserted at different heights, the lowest at a height of 3 mm in the tube; filaments c. 6.2–7 mm long, exerted portion c. 3.5 mm; two filaments villous towards the base. Style c. 6.4 mm long; stigma lobes c. 1.2 mm. Disc c. 0.7 mm long. Nutlets 4, c. 1500  $\times$  800  $\mu$ m, lanceolate, ruminant.

DISTRIBUTION. Western China (Yunnan, Salween Irrawaddy divide, and valley of the Salween). Amongst rocky scrub on dry rocky hillsides.

SPECIMENS EXAMINED. Forrest 875 (E, K-isotypes), Henry 9082 (K), Henry 11174 (K), Henry 12563 (K).

II. Subgenus **ALLOPOGOSTEMON** Bhatti & Ingr., **subgen. nov.**

*Pogostemon* section *Racemosa* Benth., pro parte.

Inflorescentia plerumque simplex. Bracteae lanceolatae, lineares vel filiformis. Calyx tubulosus, actinomorpha, 5 nervi medii plus usque ad 5 nervos secundarios marginem attingentes, introrsum annulo hirsuto. Filamentis a basi villosis vel glabris, a medium pilibus moniliformibus vel glabris.

Inflorescence normally an unbranched verticillaster, bracts lanceolate, linear or filiform, equalling or much smaller than calyx; calyx with 5 main rib veins plus isolated  $\pm$  branched secondaries reaching sinuses of teeth, calyx interior glabrous or with a continuous or broken annulus of hairs around top of tube and teeth; filament bases densely villous or glabrous, with or without moniliform hairs.

IIa. Section **RACEMOSUS** (Benth.) Bhatti & Ingr., **stat. nov.**

*Pogostemon* section *Racemosa* Benth., *Pogostemon* section *Barbata* Briq., pro parte.

Inflorescence, bracts and bracteoles linear to linear-lanceolate, large or small, verticillaster unbranched, or if branched then calyx with 5 main rib veins plus isolated  $\pm$  branched secondaries from sinuses of teeth, with an annulus of hairs around top of tube and teeth, or filament bases densely villous.

IIa i. Subsection **RACEMOSUS**

With moniliform hairs on the filaments.

22. ***Pogostemon nilagiricus*** Gamble, *Fl. Madras*: 1134 (1924). Figs 7a, 21a.

Stem solid, bluntly terete; hairs whitish, 12-celled, c. 2500  $\mu$ m long. Leaves ovate, c. 45  $\times$  33 mm, base rounded, apex bluntly acute, margin crenate, with shiny hairs on both sides of lamina; hairs 10-celled, c. 2500  $\mu$ m long. Petiole c. 10 mm long; hairs similar to those of leaves. Inflorescence a single terminal spike up to 80 mm long, dense; glandular and eglandular hairs on stalk, eglandular hairs 10-

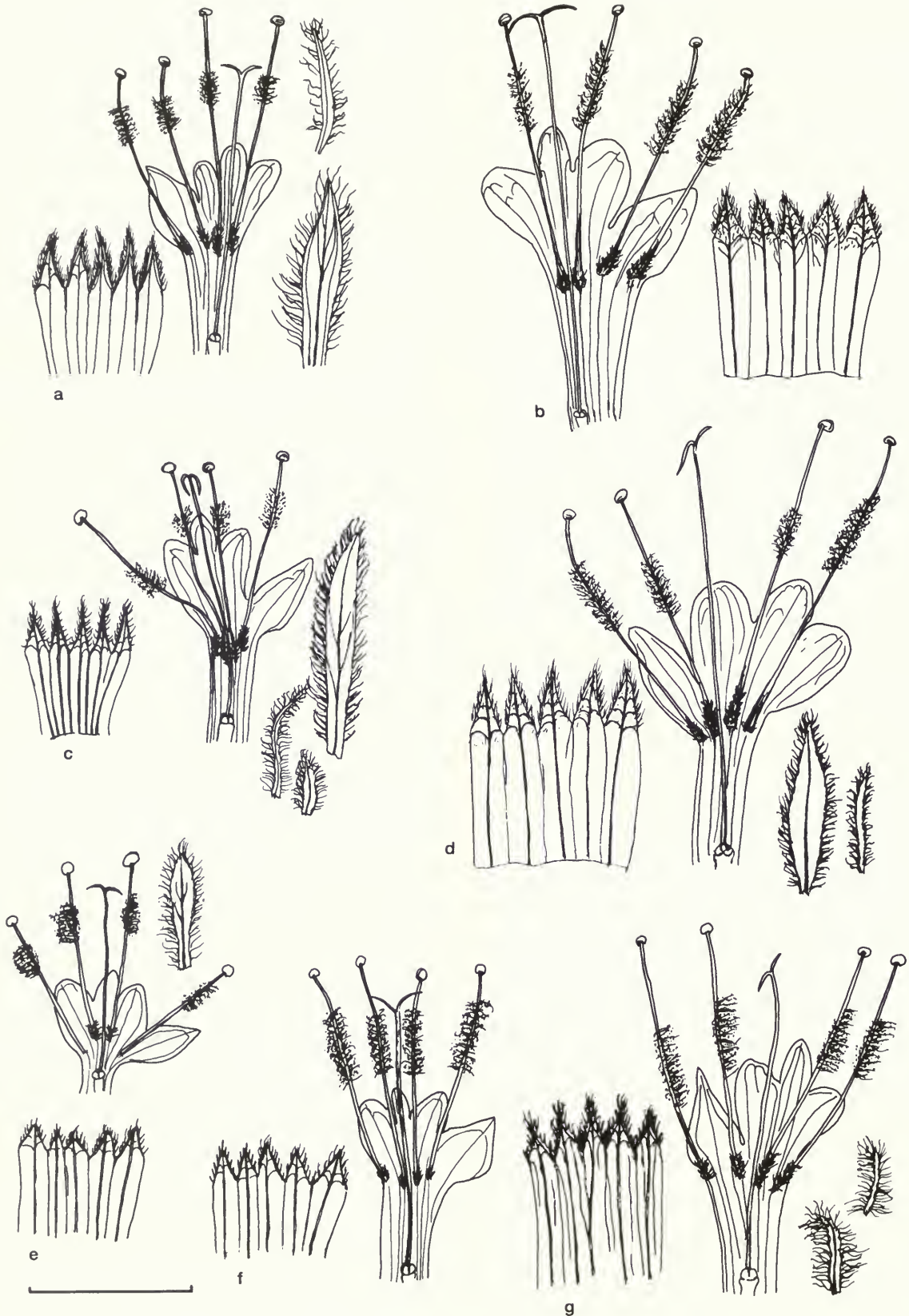


Fig. 7 Dissected corollas, calyces and bracts, showing inner surface. *Pogostemon* subgenus *Allopogostemon* section *Racemosus* subsection *Racemosus*: (a) *P. nilagaricus*, (b) *P. vestitus*, (c) *P. mollis*, (d) *P. rotundatus*, (e) *P. rupestris*, (f) *P. rogersii*, (g) *P. petiolaris*. Scale bar 5 mm.



celled, *c.* 2500  $\mu$ m long; bracts lanceolate or linear, 4–6  $\times$  0.3–1.3 mm, hairy. Calyx tubular, *c.* 4.3  $\times$  3.5 mm, 10-veined; the tube glabrous within, the teeth sparsely hairy, outside hairy; teeth ciliate, *c.* 1.5–1.7 mm long, *c.* 0.6–0.8 mm wide at base; outer hairs 6-celled, *c.* 870  $\mu$ m long. Corolla up to 6 mm long; lower lip *c.* 2.3  $\times$  1.1 mm; upper lip *c.* 1.5 mm across; central lobe *c.* 1.6  $\times$  0.8 mm; upper and lower lip hairy outside. Filaments inserted at different heights, the lowest at a height of 3 mm in the tube; filaments *c.* 5.0–5.5 mm long, exerted portion *c.* 2.5 mm; filaments thickened towards the base, the two filaments under upper lip more hairy at the base. Style *c.* 8 mm long; stigma lobes *c.* 0.5 mm. Disc *c.* 0.4 mm long. Nutlets 4, *c.* 500  $\mu$ m, orbicular, dark brown to black, reticulate-foveate with secondary reticulation.

**DISTRIBUTION.** Southern India, Nilagiri (Kunda Hills near Ootacamund).

**SPECIMENS EXAMINED.** *Bourne* s.n. (K-isotypes), *Hooker* s.n. (K), *Rao* 46997 (CAL).

**23. *Pogostemon mollis* Benth., *Labiata. gen. spec.*: 155 (1833).**  
Figs 7c, 21c.

Stem solid, terete; hairs 6-celled, *c.* 1750  $\mu$ m long. Leaves ovate, soft, *c.* 32  $\times$  24 mm, base rounded, apex obtuse, margin double dentate; hairs 4-celled, *c.* 1500  $\mu$ m long. Petiole *c.* 8 mm long; hairs 7-celled, *c.* 2000  $\mu$ m long. Inflorescence a single terminal spike, *c.* 55 mm long, lax below and dense above; hairs 6-celled, *c.* 1000  $\mu$ m long; bracts linear or filiform, 1.5–7.5  $\times$  0.2–0.9 mm. Calyx infundibular, *c.* 3.8  $\times$  4.0 mm, 10-veined; very hairy outside, glabrous within; teeth ciliate, *c.* 1.3–1.5 mm long, *c.* 0.7–0.8 mm wide at base; outer hairs 5-celled, *c.* 410  $\mu$ m long. Corolla up to 5.5 mm long; lower lip *c.* 2.1  $\times$  1.1 mm; upper lip *c.* 1.5 mm across, hairy; central lobe 1.3  $\times$  0.6 mm. Filaments inserted at more or less the same height, the lowest at a height of 1.8 mm in the tube; filaments *c.* 4.5–5.5 mm long, exerted portion *c.* 1.3 mm; filaments equally strigose at the base. Style *c.* 6.2 mm long; stigma 1.0–1.2 mm. Disc *c.* 0.4 mm long. Nutlets 4, *c.* 700  $\times$  550  $\mu$ m, orbicular, reticulate-foveate.

**DISTRIBUTION.** India (Bombay, Concan, Western Ghats, Ootacamund, Nilgiri, Kunda Hills, Pulney Hills).

**SPECIMENS EXAMINED.** *Anglade* 893 (K), *Barber* 3762 (K), *Bourne* 5355 (K), *Clarke* 10673 (BM), *Dalzell* s.n. (K), *Hooker* s.n. (K), *Vine* 216 (BM), *Wight* 2124 (K-isotype), *Wight* 2525 (K).

**24. *Pogostemon vestitus* Benth. in Wall., *Pl. asiat. rar.* 1: 31 (1830).**  
Figs 7b, 21b.

Stem solid, terete, very hairy especially at the base; hairs 7-celled, *c.* 1500  $\mu$ m long. Leaves ovate, soft felted, 40  $\times$  30 mm, base rounded, apex acute, margin dentate; hairs *c.* 5-celled, *c.* 1100  $\mu$ m long. Petiole *c.* 25 mm long; hairs 5-celled, *c.* 1200  $\mu$ m long. Inflorescence a single terminal spike, *c.* 30 mm long, dense; hairs 5-celled, *c.* 1500  $\mu$ m long. Calyx tubular, 5.8  $\times$  4.8 mm, 10-veined; densely hairy outside, teeth hairy within; teeth ciliate, *c.* 0.6–0.8 mm long, *c.* 0.7–0.9 mm wide at base; outer hairs 3-celled, *c.* 3200  $\mu$ m long. Corolla *c.* 8.6 mm long; lower lip *c.* 3  $\times$  2 mm; upper lip *c.* 2.5 mm across; central lobe *c.* 1.4  $\times$  1.1 mm wide at base. Filaments inserted at different heights in the tube, the lowest at a height of 4.5 mm in the tube; filaments *c.* 7.0–8.5 mm long, exerted portion *c.* 1.5 mm, two filaments tomentose at the base. Style *c.* 12 mm long; stigmas *c.* 1.2 mm. Disc *c.* 0.4 mm long. Nutlets 4, *c.* 600  $\times$  500  $\mu$ m, oblong, reticulate-foveate.

**DISTRIBUTION.** Southern India (western Tamil Nadu).

**SPECIMENS EXAMINED.** *Heyne* 1534 (BM, K-syntypes), *Heyne* 1561 (BM-syntype), *Wight* 2126 (K), *Wight* 2527 (E, K-syntypes).

**25. *Pogostemon petiolaris* Benth. in A. DC., *Prodr.* 12: 154 (1848).**  
Figs 7g, 23a.

Stem solid, angular; hairs 7-celled, *c.* 1100  $\mu$ m long. Leaves ovate, *c.* 55  $\times$  41 mm, base truncate, apex acute, margin double dentate; hairs 6-celled, *c.* 900  $\mu$ m long. Petiole 32 mm long; hairs 7-celled, *c.* 1000  $\mu$ m long. Inflorescence a single terminal spike, *c.* 75 mm long; hairs 6-celled, *c.* 1200  $\mu$ m long; bracts filiform, 2–3  $\times$  0.1–0.3 mm, hairy. Calyx tubular, 5.0  $\times$  5.2 mm, 5-veined; with a few long hairs outside, glabrous within, except at the tip of the teeth; teeth ciliate, *c.* 1.2–1.5 mm long, *c.* 0.9–1.2 mm wide at base; outer hairs 6-celled, *c.* 1000  $\mu$ m long. Corolla up to 6.5 mm long; lower lip *c.* 2.5  $\times$  1.2 mm; upper lip *c.* 1.6 mm across; central lobe *c.* 1.7  $\times$  0.7 mm. Filaments inserted at different heights, the lowest at a height of 2 mm in the tube; filaments *c.* 6.2–7.5 mm long, exerted portion *c.* 3 mm; filaments strigose towards the base, the two upper more densely. Style *c.* 8.2 mm long; stigma lobes *c.* 0.7–0.8 mm. Disc *c.* 1 mm long. Nutlets 4, *c.* 600  $\times$  500  $\mu$ m, orbicular, reticulate-foveate with secondary reticulation.

**DISTRIBUTION.** Southern India (Western Ghats).

**SPECIMENS EXAMINED.** *Hohenacker* 1224 (BM, K).

**26. *Pogostemon rupestris* Benth., *Labiata. gen. spec.*: 156 (1833),  
non *Dysophylla rupestris* Dalzell (1851).**  
Figs 7e, 22b.

Annual herb with straggling branches; stem angular, swollen and rooting at the nodes, glabrous except for a ring of hairs at the nodes. Leaves ovate to ovate-lanceolate, up to 25  $\times$  15 mm, base cuneate to truncate, apex acute, margin dentate towards the apex, lamina sparsely hairy and glandular-punctate; hairs 4-celled, *c.* 400  $\mu$ m long. Petiole up to 15 mm long; hairs similar to those of lamina. Inflorescence a single terminal spike, *c.* 40 mm long, lax; hairs on the stalk 4-celled, *c.* 400  $\mu$ m long; bracts lanceolate to spatulate, *c.* 4.0  $\times$  0.9 mm, hairy. Calyx tubular to urceolate, *c.* 3.5  $\times$  3.8 mm, 10-veined; glabrous within, outside with sparse hairs above; teeth unequal, triangular, apex blunt, margins ciliate, *c.* 0.9–1.1  $\times$  0.7 mm; outer hairs *c.* 4-celled, 400  $\mu$ m long. Corolla *c.* 4.6 mm long, rose or pinkish; lower lip *c.* 2  $\times$  1.3 mm; upper lip *c.* 2.8 mm across, central lobe *c.* 1.1  $\times$  0.9 mm. Filaments all inserted at a height of *c.* 2 mm in the tube, *c.* 4.0–5.2 mm long, exerted portion *c.* 2.6 mm; two filaments under central lobe slightly hairy at the base, staminal hairs towards the middle blue. Style *c.* 6.2 mm long; stigma lobes *c.* 0.6 mm long. Disc *c.* 0.3 mm long. Mature nutlets 2 or 4, *c.* 570  $\times$  500  $\mu$ m, orbicular, light brown, shiny, reticulate-foveate.

**DISTRIBUTION.** Sri Lanka (Adam's Peak, Kandy Distr., Nuwara-Eliya). Growing in shade on the damp floor of secondary montane forest.

**SPECIMENS EXAMINED.** *Cramer* 3800 (K), *Cramer* 3807 (E), *Cramer* 4277 (K), *Cramer* 4390 (E, K), *Cramer & Jayasuriya* 3725 (E), *Macrae* 396 (K-holotype), *Thwaites* 343 (BM).

**27. *Pogostemon rogersii* N.E. Br. in *Bull. misc. Inf. R. bot. Gdns, Kew* [1909]: 379 (1909).**  
Figs 7f, 22c.

Stem procumbent, rooting at the nodes, solid, angular; hairs 5-celled, *c.* 430  $\mu$ m long. Leaves elliptic to elliptic-oblong, soft-flaccid, 62  $\times$  24 mm, base cuneate, apex acute, margin serrate; hairs 4-celled,

c. 450 µm long. Petiole c. 20 mm long; hairs 4-celled, 480 µm long. Inflorescence a terminal spike, c. 30 mm long, dense, with more than two lateral spikes; hairs 5-celled, c. 720 µm long. Calyx infundibular, 2.1 × 2.2 mm, 10-veined; hairy outside, glabrous within; teeth ciliate, c. 0.7–0.9 mm long, c. 0.4–0.5 mm wide at base; outer hairs up to 6-celled, c. 950 µm long. Corolla 6.4 mm long, whitish violet; lower lip c. 1.9 × 1.4 mm; upper lip c. 1.7 mm across; central lobe 1.4 × 0.5 mm. Filaments inserted at different heights, the lowest at a height of 3.4 mm in the tube; longest filament c. 5.5–5.7 mm long, exerted portion c. 2.7 mm; filaments equally villous at base. Style c. 7.7 mm long; stigmas c. 1.1 × 1.4 mm, violet-purple. Disc c. 0.5 mm long. Nutlets 4, c. 400 × 300 µm, orbicular, reticulate-foveate.

**DISTRIBUTION.** Southern Africa (Zimbabwe, Zambia, Angola, South Africa, Mozambique). In marshy ground.

**ETHNOBOTANY.** Produces edible 'tubers'.

**SPECIMENS EXAMINED.** *Fanshawe* 3435 (K), *Fanshawe* 9336 (K), *Gossweiler* 14137 (K), *Henriques & Brites* 1132 (K), *Hundt* 149 (BM), *Johnston* 983 (K), *Multimushii* 1023 (K), *Rogers* 8314 (K-holotype), *Silva* 3801 (K), *Stohm* 123 (K).

According to Brown (1909) this was the first species of *Pogostemon* to be reported from Africa and it is quite distinct from Asiatic species.

**28. *Pogostemon rotundatus* Benth.** in Wall., *Pl. asiat. rar.* **1**: 31 (1830).

Figs 7d, 22a.

Stem solid, terete; hairs 7-celled, c. 2300 µm long. Leaves orbicular, c. 50 × 25 mm, base truncate to cordate, apex obtuse, margin double crenate; hairs shiny, whitish, 7-celled, c. 1300 µm long. Petiole up to 20 mm long; hairs 7-celled, c. 2000 µm long. Inflorescence a single terminal spike up to 110 mm long, flowers in whorls, arranged side-by-side; hairs 7-celled, c. 2000 µm long; bracts lanceolate to filiform, 3.5–5.5 × 0.2–1.2 mm. Calyx tubular, c. 6 × 5.5 mm long, 10-veined; very hairy outside, especially the teeth, more or less glabrous within; teeth ciliate, c. 1.6–1.9 mm long; outer hairs up to 4-celled, c. 900 µm long. Corolla c. 9 mm long; lower lip 3 × 1.8 mm; upper lip c. 3 mm across, villous outside; central lobe c. 2.4 × 1.5 mm. Filaments inserted at different heights, the lowest at a height of 3.7 mm in the tube; filaments c. 8–9 mm long, exerted portion c. 3.7 mm; filaments widening towards the base, the two upper densely strigose towards the base. Style c. 13 mm long; stigma lobes c. 0.5–1 mm. Disc c. 0.5 mm long. Nutlets 4, c. 400 × 300 µm, oblong, black, covered by more or less circular scales.

**DISTRIBUTION.** Southern India (Madras).

**SPECIMENS EXAMINED.** *Heyne* s.n. (K-syntype), *Wallich* 1535 (K-syntype).

**29. *Pogostemon philippinensis* S. Moore** in *J. Bot., Lond.* **43**: 146 (1905).

Figs 8a, 23b.

Stem solid, angular; hairs 4-celled, c. 280 µm long. Leaves ovate, 68 × 34 mm, base rounded, apex acute, margin dentate; hairs 5-celled, c. 500 µm long. Petiole 20 mm long; hairs 4-celled, c. 440 µm long. Inflorescence a single terminal spike, c. 125 mm long, lax below, dense above; hairs 5-celled, 600 µm long; bracts lanceolate to filiform, 1.3–4.5 × 0.2–1.5 mm, hairy. Calyx tubular, 5.6 × 5.0 mm, 10-veined; hairy outside especially on veins, only teeth hairy within, with a few hairs; teeth ciliate, c. 0.9–1.0 mm long, 0.9–1.0 mm wide at base; outer hairs 3-celled, c. 370 µm long. Corolla up to 9 mm

long; lower lip c. 2.5 × 1.9 mm; upper lip c. 2.3 mm across, hairy; central lobes c. 1.5 mm long, c. 1 mm wide at base. Filaments inserted at different heights, the lowest at a height of 4.5 mm in the tube; filaments c. 8.4–9.0 mm long, exerted portion c. 4.5 mm; two filaments villous towards the base. Style c. 12 mm long; stigma lobes 1.1–1.2 mm. Disc c. 0.5 mm long. Nutlets 4, c. 400 × 200 µm, oblong, reticulate.

**DISTRIBUTION.** East Indies, Philippines (Panay, Luzon), and Mariana Islands.

**SPECIMENS EXAMINED.** *Ramos* 33320 (BM, K), *Ramos & Edano* 45012 (BM), *Santos* 31792 (BM), *Vidal* 1659 (K), *Vidal* 3421 (K-syntype), *Whitehead* s.n. (BM-syntype),

**30. *Pogostemon velatus* Benth.** in A. DC., *Prodr.* **12**: 155 (1848). Figs 8b, 23c.

Stem solid, angular; hairs dendromorphic and fruticose, 6-celled, c. 1250 µm long. Leaves ovate, 33 × 19 mm, base rounded, apex obtuse, margin dentate, hairs dendromorphic and fruticose, 4-celled, c. 1100 µm long. Petiole c. 5 mm long; hairs dendromorphic and fruticose, 9-celled, c. 1750 µm long. Inflorescence a single terminal spike, c. 165 mm long, dense; hairs dendromorphic; bracts linear or filiform, 2.5–7.0 × 0.3–0.5 mm, hairy. Calyx tubular, 5.4 × 4.1 mm, 10-veined; densely hairy outside, margin of teeth hairy within, otherwise glabrous; teeth ciliate, c. 1.0–1.2 mm long, c. 0.8–1.0 mm wide at base; outer hairs dendromorphic, 4-celled, c. 465 µm long. Corolla up to 8 mm long; lower lip c. 2.5 × 1.4 mm; upper lip c. 2.5 mm across, hairy outside; central lobe c. 1.2 × 0.9 mm. Filaments inserted at different heights, the lowest filaments at a height of 3.8 mm in the tube; filaments c. 8.0–8.8 mm long, exerted portion c. 4.6 mm; two filaments strigose towards the base. Style c. 10 mm long; stigma lobes 1.1–1.2 mm. Disc c. 0.5 mm long. Nutlets 4, c. 500 × 300 µm, oblong, spinulose.

**DISTRIBUTION.** Philippines (Luzon).

**SPECIMENS EXAMINED.** *Cuming* 1097 (BM, K-isotypes), *Elmer* s.n. (BM), *Loher* 4209 (K), *McGregor* 11339 (BM), *Mendoza* 40923 (BM), *Merrill* s.n. (BM).

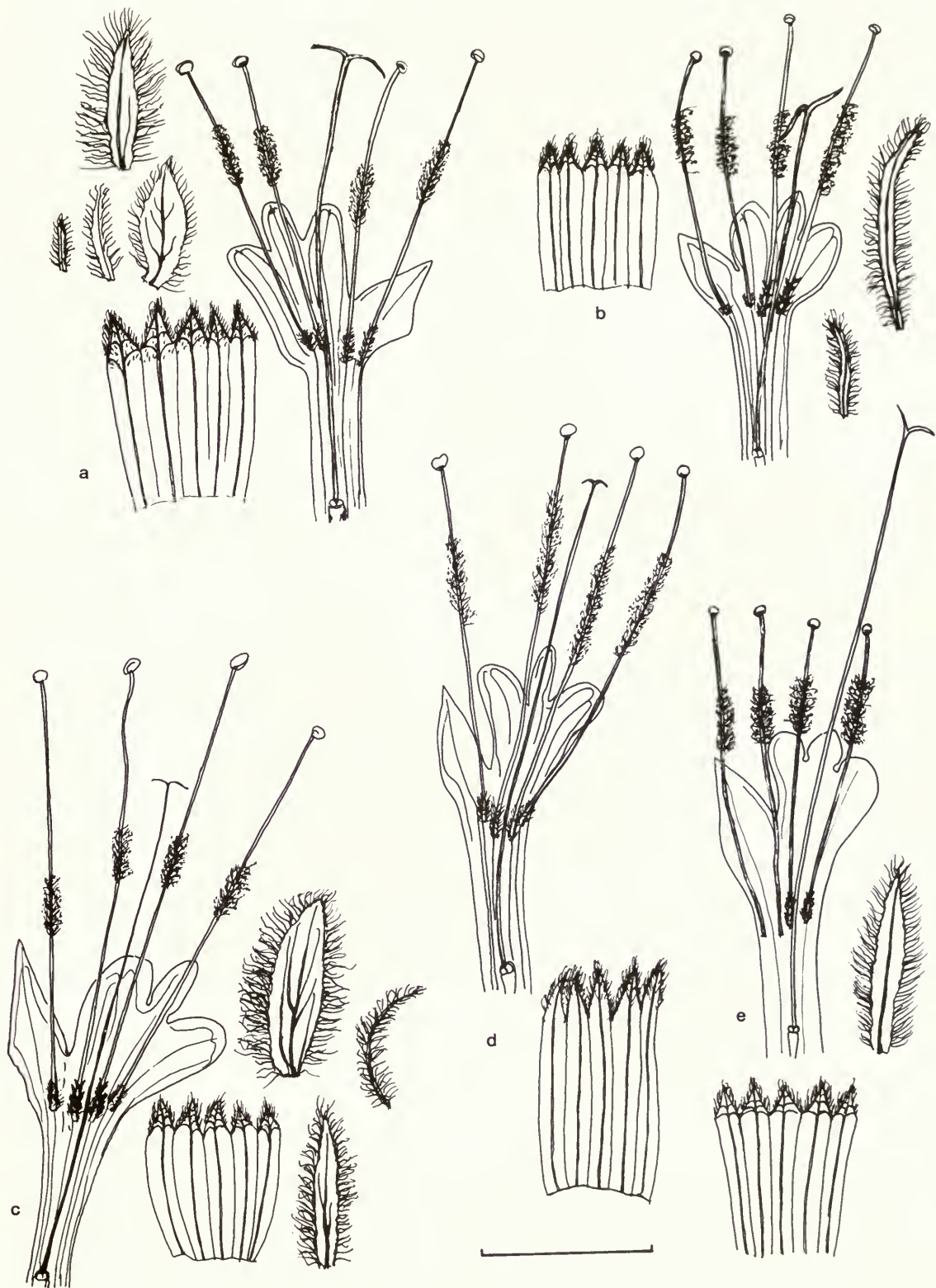
**31. *Pogostemon williamsii* Elmer** in *Leaf. Philipp. Bot.* **9**: 3197 (1934).

Figs 8c, 24a.

Stem solid, terete; hairs dendromorphic and fruticose, 5-celled, c. 600 µm long. Leaves lanceolate, c. 105 × 35 mm, base cuneate, apex acuminate, margin crenate; hairs fruticose, 5-celled, c. 800 µm long. Petiole 26 mm long; hairs fruticose, 5-celled, c. 800 µm long. Inflorescence a single terminal spike, c. 95 mm long, dense; hairs fruticose, 5-celled, c. 815 µm long; bracts lanceolate to filiform, 4.0–6.0 × 0.2–1.5 mm, hairy. Calyx tubular, 5.0 × 4.3 mm, 10-veined; sparsely hairy outside, margin of teeth hairy within; teeth ciliate, c. 0.6–0.8 mm long, c. 0.7–0.9 mm wide; outer hairs fruticose, 4-celled, c. 650 µm long. Corolla up to 8 mm long; lower lip c. 2.5 × 1.5 mm; upper lip c. 2.7 mm across, hairy outside; central lobe 1.5 × 0.8 mm wide at base. Filaments inserted at different heights, the lowest at a height of 3.5 mm in the tube; filaments c. 10–11 mm long, exerted portion c. 6.5 mm; two filaments strigose towards the base. Style c. 12 mm long; stigma lobes c. 1.1–1.2 mm. Disc c. 0.6 mm long. Nutlets 4, c. 900 × 600 µm, ellipsoid to ellipsoid-oblong, spinulose.

**DISTRIBUTION.** Philippines (Luzon, Mt. Pinatubo, Mt. Semenublam, Baguio, Benguet).





**Fig. 8** Dissected corollas, calyces and bracts, showing inner surface. *Pogostemon* subgenus *Allopogostemon* section *Racemosus* subsection *Racemosus*: (a) *P. philippinensis*, (b) *P. velatus*, (c) *P. williamsii*, (d) *P. membranaceus*, (e) *P. elatispicatus*. Scale bar 5 mm.

SPECIMENS EXAMINED. *Elmer* 22225 (BM, K-isotypes), *Iwatsuki, Murata & Gutierrez* 318 (K), *Merrill* 11673 (BM, K).

Keng (1978) and Press (1982) treated *Pogostemon williamsii* as conspecific with *P. velatus* but it differs in its trichomes, nutlets, and leaf shape.

32. ***Pogostemon membranaceus* Merr. in *Philipp. J. Sci. (Bot.)* 7: 347 (1912).**

Figs 8d, 24b.

Stem solid, terete; hairs 4-celled, c. 370 µm long. Leaves ovate, c. 70 × 34 mm, base cuneate, apex acute, margin crenate; hairs 3-celled, c. 250 µm long. Petiole c. 14 mm long; hairs 4-celled, c. 400 µm long. Inflorescence a single terminal spike c. 140 mm long, lax below, dense above; hairs 5-celled, c. 600 µm long; bracts early deciduous. Calyx tubular, 7.0 × 4.0 mm, 10-veined; hairy outside, glabrous within except at the tip of the teeth; teeth ciliate, c. 1.2–1.4 mm long, c. 0.7–0.9 mm wide at base; outer hairs 3-celled, c. 376 µm long. Corolla up to 8.5 mm long; lower lip c. 2 × 1.1 mm; upper lip c. 2 mm across; central lobe 1.3 × 0.6 mm. Filaments inserted at different heights, the lowest at a height of 4.3 mm in the tube; filaments c. 7.5–8.8 mm long, exerted portion c. 4.6 mm; filaments equally tomentose towards the base. Style c. 12.5 mm long; stigma lobes c. 0.5 mm. Disc c. 7 mm long. Nutlets 4, c. 800 × 300 µm, 'D'-shaped, reticulate.

DISTRIBUTION. Philippines (Luzon, Laguna, San Antonio).

SPECIMENS EXAMINED. *Ramos* 16419 (BM-holotype), *Ramos* 14419 (K), *Ramos* 16596 (K).

33. ***Pogostemon elatispicatus* Bhatti & Ingr., sp. nov.**

Figs 8e, 24c.

Herbae hirsutae. Caules subquadrangulati. Folia opposita, lamina 25–75 × 20–35 mm, ovata, crenata, petioli 10–25 mm, abaxialis hirsuta, dendropilis et simplipilis, adaxialis glabrata. Inflorescentia terminalis ad 230 mm, laxa vel densa ordinate verticillastris numerosis multifloribus; bractae c. 4.0–5.0 × 1.0 mm, lanceolatae, hirsutae. Calyx tubulatus, tubo 5.0 mm longo, dentibus quinque 0.9–1.3 mm longis, triangularibus, sub fructu incurvatis. Corolla bilabiata purpurea, tubo ad 8.4 mm longo exserto, labio superiori lobus centralis 1.3 × 0.8 mm, labio inferiori 2.3 × 1.5 mm longo integro. Stamina quator filamentis exsertis, pari inferiori longiori, prope medianum pilis longis barbati, prope inferior villosus; antherae uniloculares. Discus non lobatus. Nuculae maturae quatuor, semi-quaternari-spherioideus, spinifer.

TYPE. Philippines, Luzon, Ilocos, Norte Prov., Mt. Darna, February–March 1953, *Edaño* 18046 (BM!-holotype).

Stem solid, terete; hairs 6-celled, c. 780 µm long. Leaves ovate, 25–65 × 20–35 mm, base cuneate, apex acuminate, margin crenate; hairs simple-uniseriate on the adaxial surface, 6-celled, c. 870 µm long; dendromorphic hairs and simple hairs on the abaxial surface. Petiole 10–25 mm long; hairs 6-celled, 870 µm long. Inflorescence a single terminal spike c. 230 mm long, verticils arranged regularly and relatively laxly; hairs 7-celled, c. 1400 µm long; bracts lanceolate, c. 4.0–5.0 × 1.0 mm, hairy. Calyx tubular, 5.0 × 4.4 mm, 10-veined; sparsely hairy outside, teeth and tube glabrous within; teeth ciliate, c. 0.9–1.3 mm long, c. 0.8–0.9 mm wide at base; outer hairs 6-celled, c. 1000 µm long. Corolla up to 8.4 mm long; lower lip c. 2.3 × 1.5 mm; upper lip c. 3 mm across; central lobe c. 1.3 × 0.8 mm. Filaments inserted at different heights, the lowest at a height of 3.7 mm in the tube; filaments c. 8.9–9.3 mm long, exerted portion

c. 4.6 mm; two filaments setose towards the base. Style 13.3 mm long; stigma lobes c. 0.6 mm. Disc 0.7 mm long. Nutlets 4, c. 330 × 200 µm, semi-circular or 'D'-shaped, spinulose.

DISTRIBUTION. Philippines.

This taxon has affinities with *Pogostemon philippinensis*, *P. membranaceus*, *P. williamsii*, and *P. velatus* but it differs by having dendromorphic hairs only on the abaxial surface, setose hairs at the basal part of the filaments, and semi-circular or 'D'-shaped nutlets. The verticillaster is very long with a very regular arrangement of verticils.

34. ***Pogostemon paludosus* Benth. in A. DC., *Prodr.* 12: 154 (1848).** Figs 9a, 25a.

Stem solid, angular; hairs 5-celled, c. 600 µm long. Leaves ovate, c. 70 × 35 mm, base somewhat truncate, apex obtuse, margin double crenate; hairs 5-celled, c. 700 µm long. Petiole c. 45 mm long; hairs 5-celled, c. 700 µm long. Inflorescence a single terminal spike, c. 90 mm long, lax; hairs 5-celled, c. 1000 µm long. Calyx tubular, 3.5 × 2.8 mm, 10 veins obscure, 5 veins distinct; annulus of hairs in the calyx throat, outside with long and short hairs; teeth ciliate c. 0.5–0.8 mm long, c. 0.4–0.6 mm wide at base; outer long hairs 5-celled, 750 µm long. Corolla up to 5.0 mm long; lower lip c. 1.9 × 1.5 mm; upper lip c. 2.0 mm across; central lobe 0.9 × 0.4 mm. Filaments inserted at different heights, the lowest at a height of 2 mm in the tube; filaments c. 4.0–4.5 mm long, exerted portion c. 1.5 mm; two filaments tomentose towards the base. Style c. 6 mm; stigma lobes 0.8 mm long. Ovary glandular. Disc c. 0.5 mm long. Nutlets 4, c. 650 × 600 µm, orbicular, with cup-like glands.

DISTRIBUTION. India (Nilgiri, Kunda Hills, Tamil Nadu).

SPECIMEN EXAMINED. *Klackenberg & Lundin* 116 (K).

IIa ii. Subsection **GLABRIUSCULUS** (Briq.) Bhatti & Ingr., stat. nov.

*Pogostemon* section *Racemosa* subsection *Glabriuscula* Briq.

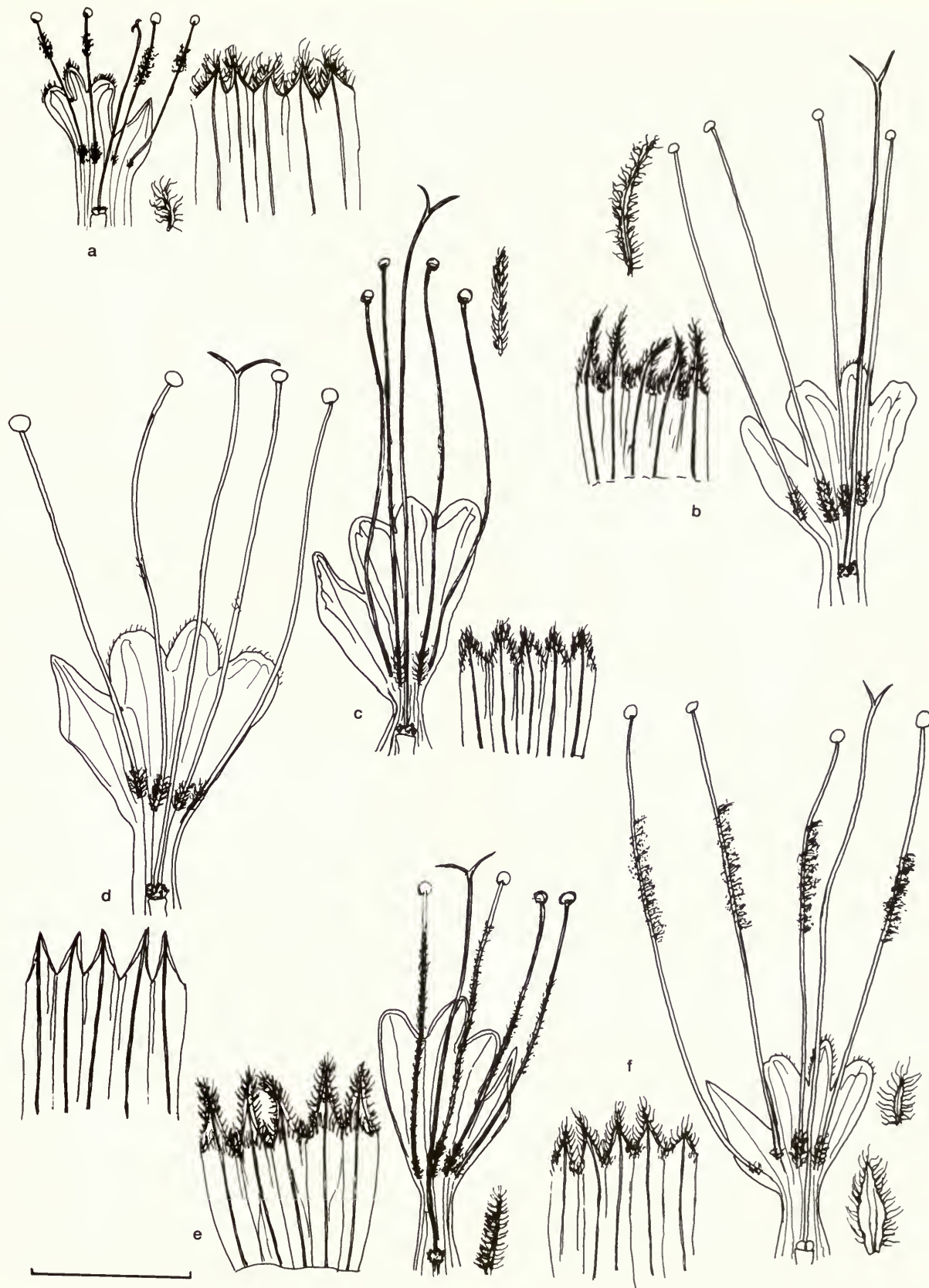
Filaments lacking moniliform hairs. A few simple hairs may be present.

35. ***Pogostemon speciosus* Benth. in Wall., *Pl. asiat. rar.* 1: 31 (1830).**

Figs 9b, 25b.

Stem solid, terete; hairs 8-celled, c. 1750 µm long. Leaves ovate, 65 × 62 mm, base cordate, apex acute, margin double crenate; hairs 6-celled, c. 1000 µm long. Petiole 60 mm long; hairs 8-celled, c. 1600 µm long. Inflorescence a single terminal spike, c. 100 mm long, dense; hairs 9-celled, c. 1700 µm long; bracts small, filiform, c. 1.0 × 0.2 mm, hairy. Calyx tubular, somewhat 2-lipped, 6.4 × 4.5 mm, 5 main veins plus a variable number of parallel minor veins reaching teeth sinuses; outside with a few scattered hairs, tufts of hairs within at the junction of the teeth; teeth ciliate, c. 2.3–2.6 mm long, c. 0.9 mm wide at base, sometimes two narrower than others; outer hairs 5-celled, c. 470 µm long. Corolla up to 7 mm long; lower lip c. 2.8 × 1.5 mm; upper lip c. 2.5 mm across; central lobe 1.6 × 0.8 mm. Filaments inserted at different heights, the lowest at a height of 2.7 mm in the tube; filaments c. 11.1–11.6 mm long, exerted portion c. 7.3 mm; filaments lacking moniliform hairs in the middle, two tomentose at the base. Style c. 14 mm long; stigma lobes c. 0.8 mm long; ovary glandular. Disc c. 0.8 mm long. Nutlets 4, c. 800 × 700 µm, ovoid, with cup-like glands.





**Fig. 9** Dissected corollas, calyces and bracts, showing inner surface. *Pogostemon* subgenus *Allopogostemon* section *Racemosus*: subsection *Racemosus* (a) *P. paludosus*; subsection *Glabriusculus*: (b) *P. speciosus*, (c) *P. atropurpureus*, (d) *P. travancoricus*, (e) *P. reflexus*; section *Zygocalyx*: (f) *P. wightii*. Scale bar 5 mm.

**DISTRIBUTION.** India (Nilgiri (Kunda Hills), Ootacamund, on the border of Kerala with Tamil Nadu).

**SPECIMENS EXAMINED.** Bourne 5314 (K), Callaro s.n. (K), Clarke 10651 (K), Gamble 11611 (K), Gamble 11630 (K), Gamble 18389 (K), Hohenacker 1225 (BM, K), Townsend & Ramamoorthy 47 (K), Schmidt s.n. (BM), Vine 215 (BM), Wight 2028 (K).

The calyx of *Pogostemon paludosus* approaches that found in species of section *Zygocalyx*.

36. ***Pogostemon travancoricus*** Bedd., *Icon. pl. Ind. or.* 1: 34 (1868–1874).

Figs 9d, 26a.

Stem solid, angular, glabrous. Leaves ovate, 50 × 38 mm, base cuneate, apex acuminate, margin crenate, lamina glabrous. Petiole c. 38 mm long, glabrous. Inflorescence a single terminal spike, c. 45 mm long, lax, glabrous. Calyx tubular, 6.3 × 5.0 mm, 10-veined; glabrous within and outside; teeth not ciliate, c. 1.3–1.8 mm long, c. 0.9–1.1 mm wide at base. Corolla up to 9 mm long; lower lip c. 2.7 × 2 mm; upper lip c. 3.8 mm across; central lobe 1.6 × 1.2 mm. Filaments inserted at different heights, the lowest at a height of 3.5 mm in the tube; filaments c. 12.8–13.9 mm long, exerted portion c. 8.4 mm; filaments glabrous towards the middle, equally villous at the base. Style c. 14.1 mm long; stigma lobes c. 1.0–1.1 mm. Ovary glandular. Disc c. 1.1 mm long. Nutlets 4, c. 1000 × 800 µm, oblong, with cup-like glands.

**DISTRIBUTION.** Southern India (Travancore).

**SPECIMENS EXAMINED.** Beddome 109 (BM, K-isotypes), Rao 3223 (K).

37. ***Pogostemon reflexus*** Benth. in A. DC., *Prodr.* 12: 155 (1848). Figs 9e, 26b.

Stem solid, terete; hairs 6-celled, c. 610 µm long. Leaves ovate, 63 × 40 mm, base truncate, apex acute, margin double crenate; hairs 5-celled, c. 500 µm long. Petiole 21 mm long; hairs 5-celled, c. 670 µm long. Inflorescence a single terminal spike, c. 115 mm long, dense; hairs 6-celled, c. 760 µm long. Calyx tubular, 6.8 × 6.0 mm, 10-veined; hairy outside, an annulus of hairs in the throat; teeth ciliate, c. 1.9–2.1 mm long, c. 1.0–1.3 mm wide at base; outer hairs 5-celled, c. 560 µm long. Corolla up to 7.7 mm long; lower lip c. 2.3 × 1.2 mm; upper lip c. 2.6 mm across; central lobe 1.5 × 1 mm. Filaments all inserted at a height of 2.8 mm in the tube, c. 8–10 mm long, exerted portion c. 2 mm; filaments glabrous towards the middle, two villous towards the base. Style c. 12 mm long; stigma lobes c. 1.1 mm. Ovary glandular. Disc c. 0.6 mm long. Nutlets 4, c. 1100 × 800 µm, oblong, with cup-like glands.

**DISTRIBUTION.** Sri Lanka (Kandy, Adam's Peak, Nuwara-Eliya).

**SPECIMENS EXAMINED.** Cramer 3483 (K), Cramer 3488 (K), Cramer 4028 (K), Cramer 4448 (K), Davidse & Sumithraarachchi 8653 (K), Moon 199 (BM), Thwaites 154 (BM), Walker s.n. (K-syntype).

38. ***Pogostemon atropurpureus*** Benth. in A. DC., *Prodr.* 12: 154 (1848).

Figs 9c, 25c.

*Pogostemon imberbe* C.H. Wright ex Hook.f., *Fl. Brit. India* 4: 637 (1885).

Stem solid, terete; hairs 5-celled, 750 µm long. Leaves elliptic to elliptic-oblong, 70 × 37 mm, base rounded, apex acute, margin

crenate to double crenate; hairs 7-celled, 600 µm long. Petiole c. 30 mm long; hairs 5-celled, c. 650 µm long. Inflorescence a single terminal spike, c. 80 mm long, dense; hairs 6-celled, c. 750 µm long. Calyx campanulate, 5.0 × 4.0 mm, 10-veined; a broken annulus of hairs in the throat, a tuft of hairs at the sinuses; teeth ciliate, c. 1.5–1.7 mm long, 0.6–0.9 mm wide at base; outer hairs 7-celled, c. 750 µm long. Corolla up to 9.4 mm long; lower lip c. 2.3 × 1.5 mm; upper lip c. 3 mm across; central lobe 1.1 × 1.1 mm. Filaments inserted at different heights, the lowest at a height of 3.2 mm in the tube; filaments c. 12–13 mm long, exerted portion c. 6.8 mm; filaments glabrous towards the middle, two villous towards the base. Style c. 15.5 mm long; stigma lobes 0.8 mm. Ovary glandular. Disc c. 1 mm long. Nutlets 4, c. 1200 × 1100 µm, oblong, with cup-like glands.

**DISTRIBUTION.** India (Kerala, Nilgiri, Kunda Hills, Anaimalai Hills).

**SPECIMENS EXAMINED.** Beddome s.n. (BM, K), Hb. Miers s.n. (BM), Wight 2127 (K-holotype).

## IIb. Section **ZYGOCALYX** Bhatti & Ingr., **sect. nov.**

Calyx plusminusve bilabiat, dentibus subulatis, fimbriatus setaceus, faucis annularis pilibus.

Calyx irregular, somewhat or markedly two-lipped, teeth awl-shaped and fringed with bristles, throat ringed by hairs, either densely or sparsely.

39. ***Pogostemon fraternus*** Miq., *Fl. Ned. Ind., Eerste bijv.* 2: 635 (1859).

Figs 10a, 26c.

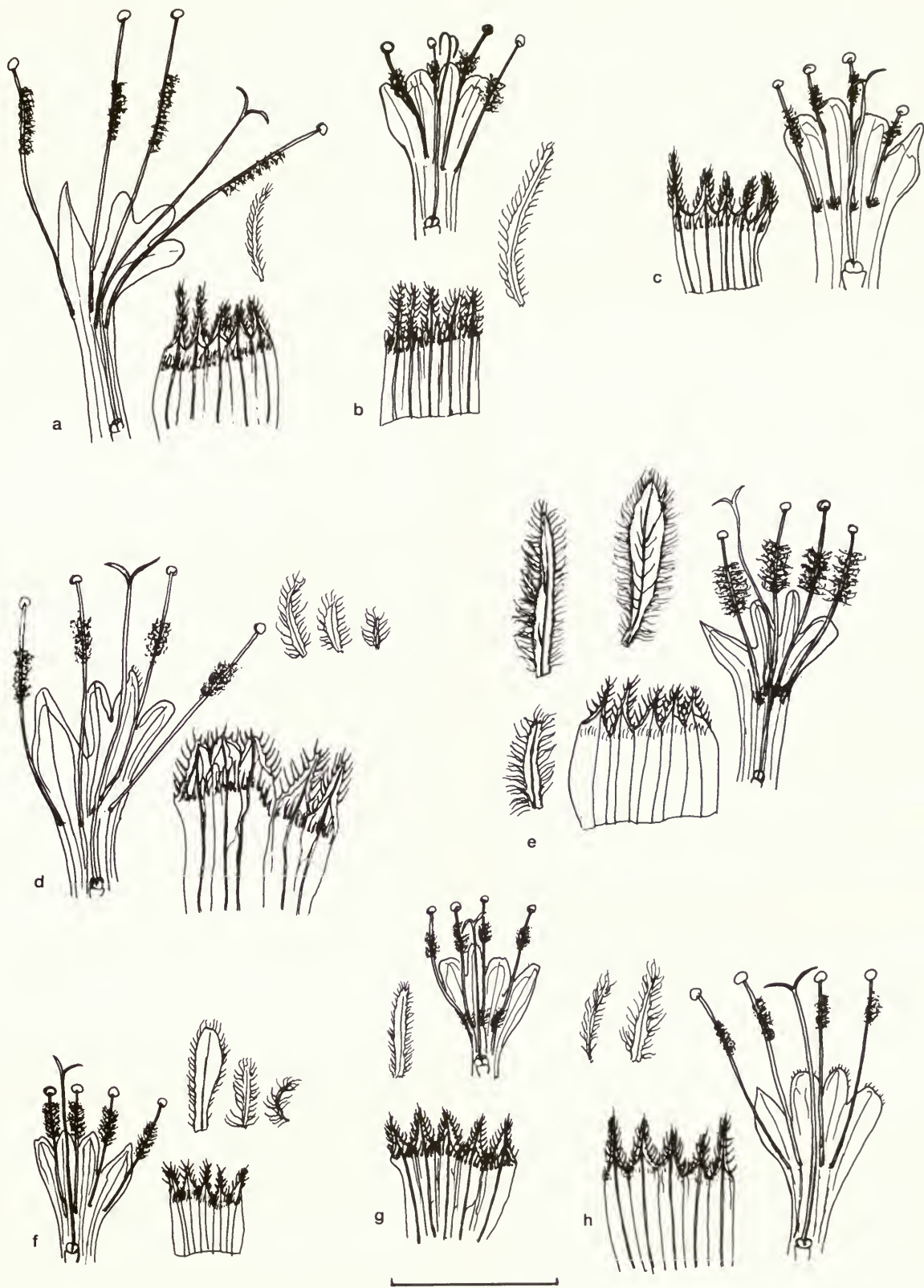
Herb up to 1 m tall; stem solid, terete, glabrous. Leaves ovate, 89 × 51 mm, base cuneate, apex acute, margin double dentate; hairs 5-celled; c. 1000 µm long. Petiole c. 45 mm long, glabrous. Inflorescence a terminal spike, c. 80 mm long, dense, with more than two lateral spikes; hairs 4-celled, c. 750 µm long. Calyx infundibular, c. 6.5 × 3.5 mm, 10-veined; sparsely hairy outside and with spherical glandular trichomes equally or more common, an annulus of hairs in the throat; teeth margin, c. 2.2–3.3 mm long, c. 0.8–1.1 mm wide at base; outer hairs 3-celled, c. 660 µm long. Corolla up to 7.5 mm long, purple- to pinkish white; lower lip c. 2.7 × 1 mm; upper lip c. 1.5 mm across; central lobe c. 1.5 × 0.6 mm. Stamens violet; filaments inserted at different heights, the lowest at a height of 3.5 mm in the tube; filaments c. 8.0–8.8 mm long, exerted portion c. 4.8 mm; filaments more or less glabrous towards the base. Style c. 11 mm long, violet; stigma lobes 0.6–0.9 mm. Disc c. 0.8 mm long. Nutlets 4, c. 1100 × 900 µm, orbicular, reticulate-foveate.

**DISTRIBUTION.** Widespread from northern India (Sikkim, Gangtok, Darjiling, Naga Hills, gorge of the Trin river, south of Saramati) to China (Yunnan, Szemao Forest) and Thailand (Chiang Mai, Kao Iwta Kao Kem, Korat, Kao Soi Dao-Chantatum, Doi Sutip, Kao Sunj, Tranj), Burma (Kachin, Keenam, Tennaserium, Chin Hills), and Java. In dry forests, on precipitous cliffs and open ground.

**SPECIMENS EXAMINED.** Bular s.n. (K), Clarke 27239A (K), Henry 11699 (K), Hooker 25 (K), Horsfield 28 (K), Hosseus 198 (BM, K), Kerr 1646 (BM, K), Kerr 3554 (BM), Kerr 4685 (BM), Kerr 9658 (BM), Kerr 15252 (BM), Kerr 16762 (BM), Kingdon-Ward 21740 (BM), Lister 20 (K), Meibold 7378 (K), Moorely s.n. (K), Tun Aung & Tha Hla 3626 (K).

Called 'Prao Lam' in Thailand. Miquel (1859) described the filaments as glabrous. Hooker (1885) clearly mentioned that Miquel found glabrous filaments in Javan plants, but noted that they were





**Fig. 10** Dissected corollas, calyces and bracts, showing inner surface. *Pogostemon* subgenus *Allopogostemon* section *Zygalyx*: (a) *P. fraternus*, (b) *P. menthoides*, (c) *P. macgregorii*, (d) *P. litigosus*, (e) *P. hirsutus*, (f) *P. brachystachyus*, (g) *P. nigrescens*, (h) *P. strigosus*. Scale bar 5 mm.

hairy towards the base in the Indian plants he examined. Mukerjee (1940) also reported stamens were only hairy towards the base, but Press (1982) scored the filaments as hairy towards the middle.

Keng (1969) regarded *Pogostemon fraternus* as a synonym of *P. menthoides*. He commented that the description of *P. fraternus* made on Horsfield's collection from G. Praoe, Java, is identical with the type specimen of *P. menthoides* at K. Hooker (1885) treated Horsfield 28 as *P. fraternus* in the *Flora of British India*. In fact, there is another specimen, Horsfield 29, which has been considered as the type of *P. menthoides*.

40. *Pogostemon menthoides* Blume, *Bijdr. fl. Ned. Ind.* 3: 825 (1826).

Figs 10b, 27a.

Stem solid, angular; hairs 5-celled, c. 600  $\mu$ m long. Leaves ovate, 45  $\times$  23 mm, base cuneate, apex acute, margin dentate; hairs 6-celled, c. 625  $\mu$ m long. Petiole 6 mm long; hairs 5-celled, c. 670  $\mu$ m long. Inflorescence a single terminal spike, c. 40 mm long, dense throughout; hairs 5-celled, c. 500  $\mu$ m long. Calyx tubular, 3.5  $\times$  3.3 mm, 10-veined; hairy outside, an annulus of hairs in the throat; teeth ciliate, c. 1.2–1.4 mm long, c. 0.5–0.8 mm wide at base; outer hairs 6-celled, c. 700  $\mu$ m long. Corolla up to 4.6 mm long; lower lip c. 2.0  $\times$  0.9 mm; upper lip c. 1.7 mm across; central lobe c. 1.1  $\times$  0.6 mm. Filaments inserted at different heights, the lowest at a height of 2 mm in the tube; filaments c. 3.5–4.3 mm long, exserted portion c. 1.7 mm; filaments more or less glabrous at the base. Style c. 4.5 mm long; stigma lobes c. 0.5 mm. Disc c. 0.5 mm long. Nutlets 4, c. 1000  $\times$  800  $\mu$ m, orbicular, reticulate-foveate.

DISTRIBUTION. Widely distributed from India (Manipur, Ukhrul) to Indonesia and Vietnam (Khu-Tu-Tri-Tay-Bac, near Chapa). Growing in patches at roadsides in the shade of the climax forest.

ETHNOBOTANY. In Java the fragrant leaves of *Pogostemon menthoides* are kept among clothes as an insect repellent.

SPECIMENS EXAMINED. Horsfield 29 (K-isotypes), Kingdon-Ward 18036 (BM), Kingdon-Ward 20423 (BM), Pételot 5110 (BM).

The filaments have been described as glabrous in various floras, but a few moniliform hairs have been observed. This is a strongly scented plant with branches rooting so that it forms a carpet.

41. *Pogostemon litigiosus* Doan in Humbert, *Fl. gen. Indo-China* 4: 972 (1936).

Figs 10d, 27c.

Stem solid, terete, rooting at the nodes; hairs 8-celled, c. 1600  $\mu$ m long. Leaves ovate, 54  $\times$  34  $\mu$ m, base truncate, apex acute, margin double dentate; hairs 7-celled, c. 1100  $\mu$ m long. Petiole 25 mm long; hairs 7-celled, 1400  $\mu$ m long. Inflorescence a single terminal spike, c. 60 mm long, lax throughout; hairs 7-celled, c. 1300  $\mu$ m long. Calyx bilabiate, 5.5  $\times$  5.5 mm, 10-veined; with scattered long hairs outside, an annulus of hairs in the throat; teeth unequal, ciliate, c. 0.8–2.3 mm long, c. 1.1–1.5 mm wide at base; outer hairs 5-celled, c. 680  $\mu$ m long. Corolla up to 6.5 mm long, white; lower lip c. 1.8  $\times$  1.5 mm; upper lip c. 1.5 mm across; central lobe 0.6–1.5 mm. Filaments inserted at different heights, the lowest at a height of 2.5 mm in the tube; filaments c. 5.2–5.4 mm long, exserted portion c. 1.4 mm; filaments glabrous towards the base. Style c. 7.7 mm long; stigma lobes c. 0.7–0.8 mm. Disc c. 0.5 mm long. Nutlets 4, c. 1200  $\times$  1000  $\mu$ m, orbicular, reticulate-foveate.

DISTRIBUTION. Only found in Sabah on the slopes of Mt Kinabalu above 1000 m. Along wet forest trails and in other wet places.

SPECIMENS EXAMINED. J. & M.S. Clemens 29042 (BM), J. & M.S. Clemens 29727 (BM), J. & M.S. Clemens 32575 (BM), J. & M.S. Clemens 40267 (BM).

This is a very distinct species, although specimens have sometimes been incorrectly identified as *Pogostemon menthoides*.

42. *Pogostemon macgregorii* W.W. Sm. in *Rec. bot. Surv. India* 6: 39 (1914).

Figs 10c, 27b.

Stem solid, erect; hairs 6-celled, c. 720  $\mu$ m long. Leaves ovate, 80  $\times$  25 mm, base rounded, apex acute, margin serrate; hairs 5-celled, c. 520  $\mu$ m long. Petiole 10 mm long; hairs 5-celled, c. 560  $\mu$ m long. Inflorescence a single terminal spike, c. 60 mm long, with 12 closely arranged verticils, the lowermost whorl of flowers separated from the rest; hairs 7-celled, c. 550  $\mu$ m long. Calyx tubular-inflated, 4.0  $\times$  3.6 mm, 10-veined; an annulus of hairs inside the tube, outside a few glandular tipped hairs present; teeth ciliate, c. 1–2 mm long, widest tooth c. 1.0–1.3 mm wide at base; outer hairs 4-celled, c. 340  $\mu$ m long. Corolla up to 6.0 mm long; lower lip 1.8  $\times$  1.3 mm; upper lip c. 2.6 mm across; central lobe c. 1.1  $\times$  0.6 mm. Filaments all inserted at a height of 2.6 mm in the tube, c. 3.8–4.5 mm long, exserted portion c. 1.1 mm; filaments equally hairy towards the base. Style c. 5.4 mm long; stigma lobes c. 0.7 mm long. Disc c. 0.9 mm long. Nutlets 4, c. 1.1  $\times$  1.1 mm, orbicular, dark brown, reticulate-foveate.

DISTRIBUTION. Northern Thailand (Pa-Ngem Chiang Mai, Doichong).

SPECIMENS EXAMINED. Garrett 438 (BM, K), Hansen & Smitinand 12661 (K), Iwatsuki, Funkuoka & Chintayungkum 9659 (K), Murata 15941 (K).

43. *Pogostemon hirsutus* Benth., *Labiat. gen. spec.*: 155 (1833).

Figs 10e, 28a.

Stem erect, solid, angular; hairs 4-celled, c. 500  $\mu$ m long. Leaves ovate, c. 26  $\times$  15 mm, base cuneate, apex acute, margin serrate; hairs 4-celled, c. 620  $\mu$ m long. Petiole c. 7 mm long; hairs 4-celled, c. 500  $\mu$ m long. Inflorescence a single terminal spike, up to 32 mm long, dense; hairs 6-celled, c. 1000  $\mu$ m long. Calyx tubular, c. 5  $\times$  4 mm, 10-veined; with scattered very long hairs outside, glabrous within; teeth unequal, ciliate, longest tooth c. 1.5 mm long, shortest c. 0.7 mm long, c. 0.5–0.7 mm wide at base; outer hairs 5-celled, c. 820  $\mu$ m long. Corolla up to 6.3 mm long; lower lip c. 2.1  $\times$  1.2 mm; upper lip c. 2.5 mm across, hairy outside; central lobe c. 1.5  $\times$  0.8 mm. Filaments inserted at different heights, the lowest at a height of 2.5 mm in the tube; filaments c. 3.2–6.3 mm, exserted portion c. 2.5 mm; filaments all more or less equally villous at the base. Style c. 7.0 mm long; stigma lobes c. 0.6 mm. Disc c. 0.5 mm long. Nutlets 4, c. 450  $\times$  300  $\mu$ m, oblong, reticulate-foveate.

DISTRIBUTION. Sri Lanka (Hakgala, Nuwara-Eliya, Matale).

SPECIMENS EXAMINED. Cramer 4872 (K), Macrae 446 (K-holotype), Simpson 9049 (BM), Thwaites 283 (BM), Townsend 73/155 (K).

44. *Pogostemon wightii* Benth., *Labiat. gen. spec.*: 156 (1833).

Figs 9f, 28b.

Stem solid, angular; hairs 9-celled, c. 1700  $\mu$ m long. Leaves ovate, 50  $\times$  43 mm, base truncate, apex acute, margin double crenate; hairs 7-celled, c. 1500  $\mu$ m long. Petiole 26 mm long; hairs 9-celled, 1400  $\mu$ m long. Inflorescence a single terminal spike, c. 70 mm long, lax; hairs 8-celled, c. 1700  $\mu$ m long. Calyx tubular, 5.7  $\times$  5.7 mm, 10-



veined; sparsely hairy outside, an annulus of hairs in the throat; teeth ciliate, c. 1.3–1.5 mm long, c. 0.8–1.1 mm wide at base; outer hairs 7-celled, c. 1500 µm long. Corolla up to 6 mm long; lower lip c. 2.2 × 1.5 mm; upper lip c. 2.5 mm across; central lobe 1.1 × 0.7 mm. Filaments inserted at different heights, the lowest at a height of 2.4 mm in the tube; filaments c. 6.0–6.5 mm long, exerted portion c. 5.0 mm; two filaments villous at the base. Style c. 7.0 mm long; stigma lobes c. 0.4–0.5 mm. Disc c. 0.8 mm long. Nutlets 4, c. 600 × 500 µm, orbicular, reticulate-foveate with secondary reticulation.

**DISTRIBUTION.** Southern India (Nilagiri, Kunda Hills, Malabar, Concan).

**SPECIMENS EXAMINED.** *Gamble* 16929 (K), *Gamble* 17853 (BM, K), *Klackenberg & Lundin* 116 (K), *Stocks & Law* s.n. (BM), *Schmidt* 74 (BM), *Wight* s.n. (K).

**45. *Pogostemon brachystachyus* Benth. in A. DC., *Prodr.* 12: 156 (1848).**

Figs 10f, 28c.

Stem solid, rooting at nodes, angular; hairs up to 6-celled, c. 900 µm long. Leaves ovate, 33 × 20 mm, base cuneate, apex acuminate, margin dentate; hairs 7-celled, c. 550 µm long. Petiole c. 6 mm long; hairs 5-celled, c. 400 µm long. Inflorescence a single terminal spike, c. 140 mm long; hairs 6-celled, c. 630 µm long. Calyx tubular, c. 4 × 3.8 mm, 10-veined; outside with a few hairs, some glandular, an annulus of hairs in the throat; teeth ciliate, c. 1.3–1.6 mm long, 0.4–0.6 mm wide at base; outer hairs 4-celled, c. 470 µm long. Corolla up to 4 mm long, bright purple; lower lip c. 1.5 × 1 mm; upper lip c. 1.3 mm across; central lobe 1.1 × 0.5 mm. Filaments inserted at different heights, the lowest at a height of 1.6 mm in the tube; filaments c. 3.5–4.0 mm long, exerted portion c. 1.6 mm; filaments glabrous towards the base. Style c. 5.2 mm long; stigma lobes c. 0.9 mm. Disc c. 0.5 mm long. Nutlets 4, c. 800 × 700 µm, orbicular, reticulate.

**DISTRIBUTION.** Northern India (Khasia, Shillong) to Burma (Sumpra Prum). A weed of open roadsides, forming mat-like colonies with ascending verticillasters.

**SPECIMENS EXAMINED.** *Clarke* 15559A (BM, K), *Clarke* 40303 (BM), *Griffith* 3967 (K-isotypes), *Kingdon-Ward* 20519 (BM, K).

In Kew herbarium there are two specimens of *Griffith* 3967 from East Bengal, dated 14 November 1834, and a third specimen dated 24 September 1850.

Bentham (1832–1836) described the filaments of *Pogostemon brachystachyus* as glabrous or nearly so (*filamentis nudis vel leviter barbatis*). Hooker (1885), Mukerjee (1940), and all other workers reported this character in the same fashion. Nevertheless, the filaments of *P. brachystachyus* are clearly densely hairy towards the middle.

**46. *Pogostemon nigrescens* Dunn in *Notes R. bot. Gdn Edinb.* 8: 159 (1913).**

Figs 10g, 29a.

Stem solid, angular; hairs 4-celled, c. 370 µm long. Leaves ovate, 30 × 20 mm, base cuneate, apex obtuse, margin crenate; hairs 4-celled, c. 275 µm long. Petiole 4 mm long; hairs 5-celled, c. 250 µm long. Inflorescence a terminal spike, c. 170 mm long, lax below, dense above, with two lateral spikes; hairs 5-celled, c. 350 µm long. Calyx campanulate, 4.0 × 4.1 mm, 10-veined; hairy outside, an annulus of hairs in the throat; teeth ciliate, c. 0.9–1.2 mm long, 0.8–0.9 mm wide at base; outer hairs 4-celled, 270 µm long. Corolla up to 3.9 mm long; lower lip c. 1.3 × 0.7 mm; upper lip c. 1.5 mm across; central

lobe 0.5–0.9 mm wide at base. Filaments inserted at different heights, the lowest at a height of 1.7 mm in the tube; filaments c. 3.2–3.5 mm long, exerted portion c. 1.3 mm; filaments equally villous towards the base. Style c. 3.9 mm long; stigma lobes c. 0.6 mm. Disc c. 0.5 mm long. Nutlets 4, c. 800 × 600 µm, obovoid, reticulate.

**DISTRIBUTION.** Western China (Yunnan).

**SPECIMENS EXAMINED.** *Forrest* 18590 (BM, K), *Henry* 9082 & 9082T (K), *Henry* 11174 (K-holotype), *Henry* 12563 (K).

**47. *Pogostemon strigosus* (Benth.) Benth. in A. DC., *Prodr.* 12: 155 (1848).**

Figs 10h, 29b.

*Dysophylla strigosa* Benth. in Wall., *Pl. asiat. rar.* 1: 30 (1830).

Stem solid, angular; hairs 4-celled, c. 875–960 µm long. Leaves lanceolate, 41–51 × 12–20 mm, base truncate to rounded, apex acute, margin serrate; hairs 5-celled, c. 1200 µm long. Petiole c. 4 mm long; hairs 5-celled, c. 800–1000 µm long. Inflorescence a single terminal spike, c. 70–108 mm long; hairs 4–5 celled, c. 1000 µm long. Calyx tubular, 4.3–5.0 × 3.2–4.2 mm, 10-veined; with scattered hairs outside, a tuft of hairs at the sinuses within; teeth ciliate slightly inside the margin, c. 0.9–1.7 mm long, 0.5–0.9 mm wide at base; outer hairs 3-celled, 620–750 µm long. Corolla up to 5.8 mm long; lower lip c. 2.0 × 1.1 mm; upper lip c. 2.1 mm across; central lobe 1.1 × 0.7 mm. Filaments all inserted at a height of 2.4–2.9 mm in the tube, c. 5.0–6.6 mm long, exerted portion c. 2.3–3.5 mm; filaments all equally villous at base. Style c. 7.0–7.8 mm long; stigma lobes c. 0.9 mm. Disc c. 0.5–0.6 mm long. Nutlets 4, c. 800–900 × 700–800 µm, obovoid, reticulate-foveate with secondary reticulation or spinulose.

**DISTRIBUTION.** India (Khasia Hills, Assam) and northeastern Bangladesh. Found in roadside woods and pastures at an elevation of 1500–1800 m.

**SPECIMENS EXAMINED.** *Clarke* 5501 (BM), *Clarke* 45456B (BM), *Griffith* 209 (BM), *Hooker* s.n. (K), *Kingdon-Ward* 18763 (BM), *Lemann* 209 (K), *Wallich* 1549 (BM, K-isotypes).

**III. Subgenus *DYSOPHYLLUS* (Blume) Bhatti & Ingr., comb. et stat. nov.**

*Dysophylla* Blume (1826), pro parte.

Stems often weak. Leaves sessile to subsessile, rarely petiolate, in whorls of more than two, rarely two opposite at each node, linear to linear-lanceolate or elliptic to elliptic-oblong, rarely ovate or orbicular. Inflorescence dense. Calyx small, infundibular, usually < 3 mm in length, 5-veined, thin and translucent, exterior usually hairy with glands obvious, circumference of the flowering calyces greater than the total length. Width of lower corolla lip usually ≥ upper, length of lower lip equal to its width at the base. Nutlets mostly oblong, rarely ellipsoid to ellipsoid-oblong or ovoid.

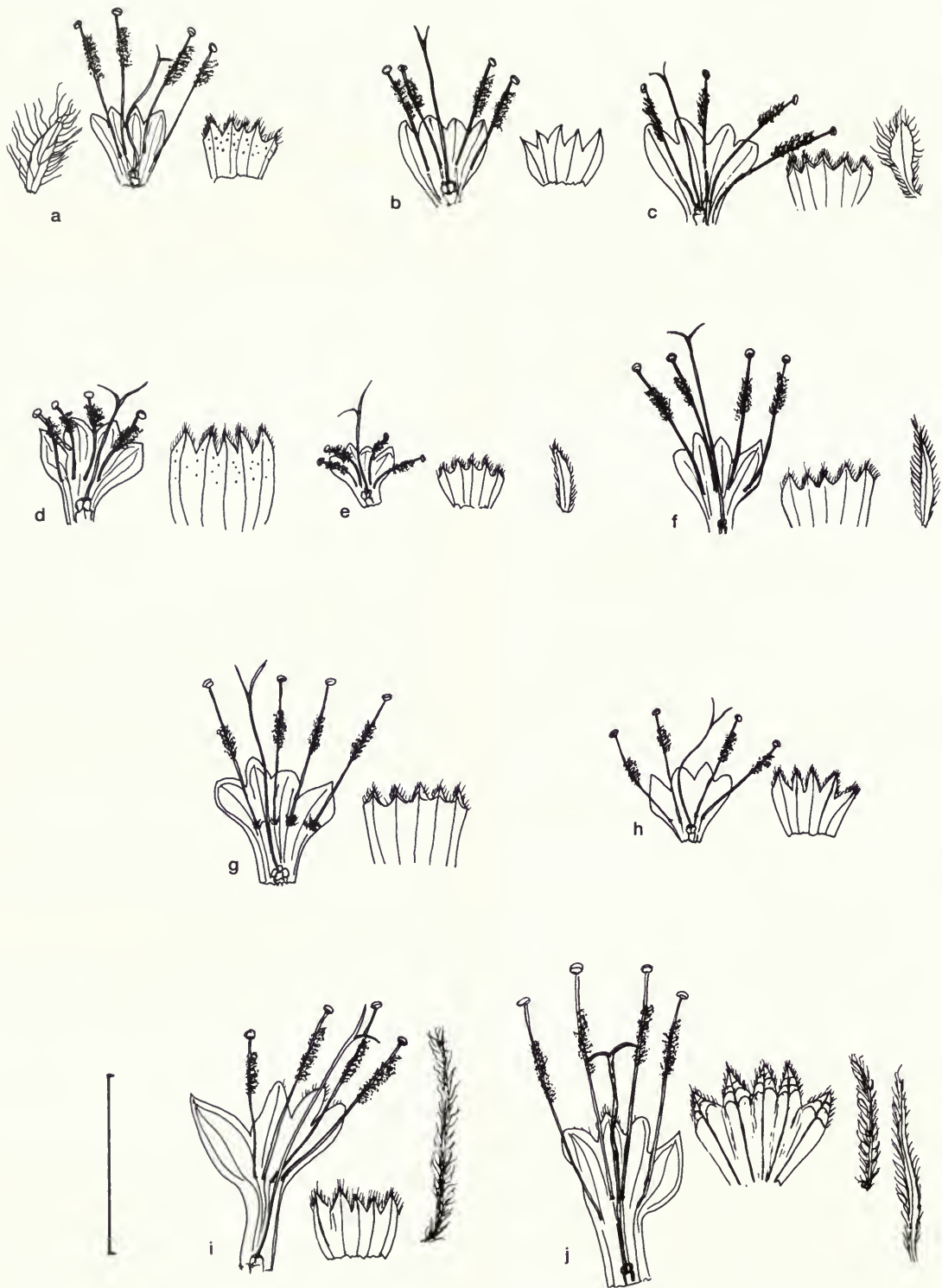
**IIIa. Section *DYSOPHYLLUS***

*Dysophylla* section *Oppositifoliae* Benth. (1832), pro parte, *Dysophylla* section *Eudysophylla* Kudô (1927), pro parte.

Leaves two, opposite at each node, shape various but commonly broadly elliptic, ovate or lanceolate, or deeply pinnatifid.

**48. *Pogostemon auricularius* (L.) Hassk. in Hoeven & de Vriese, *Tijdschr. Natuurl. Gesch. Physiol.* 10: 127 (1843).**

Figs 11a, 29c.



**Fig. 11** Dissected corollas, calyces and bracts, showing inner surface. *Pogostemon* subgenus *Dysophyllus* section *Dysophyllus*: (a) *P. auricularius*, (b) *P. glabratus*, (c) *P. barbatus*, (d) *P. amaranthoides*, (e) *P. myosuroides*, (f) *P. salicifolius*, (g) *P. quadrifolius*, (h) *P. tisserantii*, (i) *P. mutamba*, (j) *P. micangensis*. Scale bar 5 mm.



*Mentha auricularia* L., *Mant. pl.*: 81 (1767).

*Dysophylla auricularia* (L.) Blume, *Bijdr. fl. Ned. Ind.* 3: 825 (1826).

Stem procumbent and rooting at the nodes, solid, angular, contracted at the base of the internodes, pinkish; hairs up to 8-celled, c. 1200  $\mu$ m long. Leaves in opposite pairs, ovate to ovate-lanceolate, up to c. 50  $\times$  30 mm, base cuneate, apex acute, margin serrate to double serrate, lamina glandular-punctate on both surfaces; hairs 6-celled, c. 2000  $\mu$ m long. Petiole up to 5 mm long, densely hairy; hairs 8-celled, c. 2000  $\mu$ m long. Inflorescence a single terminal spike, c. 80 mm long, dense, the flowers fragrant; hairs on stalk 7-celled, c. 1600  $\mu$ m long. Floral leaves narrowly elliptic. Calyx campanulate-infundibuliform, c. 2.5  $\times$  3.5 mm, 5-veined; glabrous within, glandular and with a few hairs outside; teeth ciliate, 0.5–0.7 mm long, c. 0.8–1.0 mm wide at the base, incurved in fruit; outer hairs 4-celled, c. 500  $\mu$ m long. Corolla c. 3.5 mm long, purplish; lower lip c. 1  $\times$  0.8 mm; upper lip c. 2.8 mm across, central lobe c. 0.8  $\times$  0.6 mm. Filaments all inserted at a height of 1.6 mm in the tube, c. 4.3–4.7 mm long, exerted portion c. 2.8 mm; filaments glabrous towards the base. Style c. 5 mm long; stigma lobes c. 0.8 mm. Disc c. 0.3 mm long. Nutlets 4, c. 700  $\times$  380  $\mu$ m, ellipsoid-fusiform, brown, reticulate.

**DISTRIBUTION.** Throughout south Asia from Sri Lanka (Kandy Dist., Pussellawa, Uva Prov., Sabaragamuwa Prov.), India (Madras, Assam, Sambalpur), Malaysia, Burma (Maymo Plateau), through China (Hainan, Yunnan, Canton, Hong Kong), and south to New Guinea. Common on marshy ground and in paddy fields.

**ETHNOBOTANY.** The leaves of *Pogostemon auricularis* are crushed with lime and applied as a poultice on the abdomen for various ailments, such as diarrhoea, colic, worms, and a sore throat. Its use for disturbances of the stomach in children is very common in Malaya.

**SPECIMENS EXAMINED.** *Balcher* 721 (K), *Bourne* 663 (K), *Cramer* 4056 (K), *Cramer* 5178 (K), *Ford* 3 (K), *Henry* 12311 (K), *Henry* s.n. (K), *Hepper*, *Maxwell* & *Fernando* 4556 (K), *Hooker* 344 (K), *Jayasuriya* 1454 (K), *Lace* 4246 (K), *Lei* 886 (K), *McClure* 9279 (K), *Mooney* 1827 (K), *Parry* 267 (K), *Peng* 6250 (K), *Playfair* 124 (K), *Wiakabu* et al. 73782 (K).

49. ***Pogostemon glabratus*** Chermisr. ex Press in *Bull. Br. Mus. nat. Hist. (Bot.)* 10: 71 (1982).  
Figs 11b, 30a.

Stem erect, 4-angled, contracted at base of internodes; hairs few, 3-celled, c. 250  $\mu$ m long, golden glands present. Leaves in opposite pairs, elliptic to ovate-elliptic, c. 70  $\times$  30 mm, base cuneate, apex acute, margin dentate, lamina punctate; hairs few, white, c. 3-celled, c. 300  $\mu$ m long. Petiole c. 0.5 mm long. Inflorescence a single terminal spike, c. 90 mm long, whorls densely arranged. Calyx campanulate, c. 2  $\times$  2.5 mm, 5-veined; glabrous within, glandular outside; teeth not ciliate, c. 0.5–0.7 mm long, c. 0.4–0.7 mm wide at base. Corolla c. 2.5 mm long; lower lip c. 0.6  $\times$  0.6 mm, obtuse at apex; upper lip c. 2 mm across, with a few hairs outside; central lobe c. 0.5  $\times$  0.6 mm. Filaments all inserted at a height of c. 1 mm in the tube, c. 2.5–3 mm long, exerted portion c. 1.5 mm, glabrous towards the base. Style c. 4 mm long; stigma lobes c. 0.3 mm. Disc c. 0.3 mm long. Nutlets 4, c. 700  $\times$  500  $\mu$ m, ellipsoid-fusiform with small attachment point, light brown, reticulate-foveate.

**DISTRIBUTION.** Thailand (Hi Dat and Rachaburi, Kanburi area).

**SPECIMENS EXAMINED.** *Kerr* 10274 (BM), *Put* 132 (BM-holotype).

50. ***Pogostemon barbatus*** Bhatti & Ingr., *sp. nov.*

Figs 11c, 30b.

Herbae hirsutae. Caules ad nodo contractes, fumosi. Foliae oppositae, lamina ad 80  $\times$  19 mm, oblonga, crenata, cuneata, hirsuta in superficiebus ambabus folii, pilibus c. 1.25 mm, auricolaribus glandulibus depressibus in lamina, petioli c. 20 mm. Inflorescentia ad 90 mm, gracilis, dens, ad 30 verticillastros; bractae c. 2.5  $\times$  0.5 mm, oblanceolatae, hirsutae ad marginem. Calyx campanulatus, tubo 15  $\times$  22 mm, dentibus quinque 0.4–0.5 mm longis, ciliatus, sub fructu incurvatis. Corolla bilabiata purpurea, tubo ad 3.1 mm, labio superiori lobus centralis 1.3  $\times$  0.8 mm, labio inferiori 1.0  $\times$  1.0 mm. Stamina quator filamentis exserti, pari superiori affixus ad 2 mm corollae tubo, pari inferiori ad 1.5 mm, prope medianum pilis longis barbati, prope inferior glabratus; antherae uniloculares. Discus non lobatus. Nuculae 400  $\times$  300  $\mu$ m maturae quatuor, oblongae, reticulatae-foveatae.

**TYPE.** Hong Kong, Fau Tan Valley, 12 October 1972, *Hu* 12319 (K!-holotype).

Stem procumbent, solid, 4-angled, contracted at base of internodes, greyish brown; hairs 8-celled, c. 1250  $\mu$ m long. Leaves in opposite pairs, c. 80  $\times$  19 mm, oblong-clavate, base cuneate, apex bluntly acute, margin crenate to double crenate, lamina hirsute, glandular, the glands golden, sunken; hairs c. 5-celled, c. 750  $\mu$ m long. Petiole c. 20 mm long; hairs c. 8-celled, c. 1210  $\mu$ m long. Inflorescence a single terminal spike, up to 90 mm long, slender, with c. 30 confluent whorls; hairs 8-celled, c. 1150  $\mu$ m long. Floral leaves clavate-oblanceolate, c. 2.5  $\times$  0.5 mm; hairs only on margin, up to 5-celled, c. 750  $\mu$ m long. Calyx campanulate, c. 15  $\times$  22 mm, 5-veined inside; glabrous within, with ball-like glands outside; teeth ciliate, c. 0.4–0.5 mm long, c. 0.3–0.5 mm wide at base, incurved in fruit. Corolla c. 3.1 mm long; lower lip 1  $\times$  1 mm; upper lip c. 2 mm across; central lobe c. 0.6  $\times$  0.6 mm, sparsely hairy outside. Two filaments under central lobe inserted higher (c. 0.4 mm) than other two; filaments equal in length, c. 3.5 mm long, exerted portion c. 1.8 mm; filaments glabrous at the base, hairs towards the middle of filament on one side, c. 750  $\mu$ m long. Style c. 4 mm long; stigma lobes c. 0.5 mm. Nutlets 4, c. 400  $\times$  300  $\mu$ m, oblong, brown, reticulate-foveate.

**DISTRIBUTION.** Hong Kong.

**SPECIMENS EXAMINED.** *Hu* 5652 (K).

This species is closely allied to *Pogostemon auricularis* and *P. glabratus* but differs in having more dense and much longer hairs, longer petioles, a crenate margin to the leaf, filaments attached at different heights in the corolla tube, and oblong nutlets.

51. ***Pogostemon amaranthoides*** Benth. in A. DC., *Prodr.* 12: 153 (1848).

Figs 11d, 30c.

Herb up to 1 m high; stem solid, angular; hairs 4-celled, c. 310  $\mu$ m long. Leaves in opposite pairs, ovate, 115  $\times$  55 mm, base cuneate, apex acuminate, margin dentate; hairs 4-celled, c. 325  $\mu$ m long. Petiole c. 30 mm long, glabrous. Inflorescence a terminal spike, c. 65 mm long, lax below, dense above, with two lateral spikes; hairs 4-celled, c. 320  $\mu$ m long. Calyx campanulate, 2.8  $\times$  3.6 mm, 5-veined; hairy on ribs outside, teeth hairy on margin and just within margin; teeth c. 0.5–0.7 mm long, 0.5–0.7 mm wide at base; outer hairs 3-celled, c. 250  $\mu$ m long. Corolla up to 2.6 mm long, pinkish white; lower lip c. 0.8  $\times$  0.7 mm; upper lip c. 1.4 mm across; central lobe 0.6  $\times$  0.5 mm; lobes with a few hairs. Filaments inserted at different heights, the lowest at a height of 1 mm in the tube; filaments c. 1.5–

1.9 mm long, exerted portion c. 3 mm. Style c. 3 mm long, with a few hairs; stigma lobes c. 0.7 mm. Disc c. 0.5 mm long. Nutlets 4, c.  $600 \times 500 \mu\text{m}$ , oblong, punctulate.

**DISTRIBUTION.** Eastern Himalayas (Tibet (Ham Tawai valley), Sikkim, Khasia, Darjiling, Bhutan, Chukka Dist. Chukka Dzong Nepal).

**SPECIMENS EXAMINED.** *Clarke* 9520A (K), *Clarke* 24838B (K), *Dawson* 257 (BM), *Gamble* 7171 (K), *Gamble* 3850A (K), *Gamble* 488388 (K), *Grierson & Long* 3227 (K), *Griffith* 212 (K), *Hara et al.* 06306529 (BM, K), *Hooker* s.n. (BM), *Hooker* s.n. (K-syntype), *Hooker* s.n. (K), *Kingdon-Ward* 7410 (K), *Manandhar* 8348 (BM), *Stanton, Sykes & Williams* 9276 (BM).

**52. *Pogostemon myosuroides* (Benth.) Kuntze, *Rev. gen. pl.* 2: 530 (1891).**

Figs 11e, 31a.

*Dysophylla myosuroides* Benth. in Wall., *Pl. asiat. rar.* 1: 30 (1830). *D. rugosa* Hook.f., *Fl. Brit. India* 4: 638 (1885).

*Pogostemon rugosus* (Hook.f.) El Gazzar & L. Watson in *Taxon* 16: 187 (1967).

Stem erect, solid, terete, greyish because of hairs; hairs 4-celled, c.  $550 \mu\text{m}$  long. Leaves in opposite pairs, lanceolate, c.  $40 \times 7 \text{ mm}$ , base cuneate, apex bluntly acute, margin sharply dentate, lamina thick, densely hairy on both sides, veins strongly developed; hairs 3-celled, c.  $500 \mu\text{m}$  long. Petiole c. 3 mm long; hairs 4-celled, c.  $560 \mu\text{m}$  long. Inflorescence a terminal spike, c. 50 mm long, dense, with lateral spikes, c. 30 mm long, dense; hairs 4-celled, c.  $550 \mu\text{m}$  long. Floral leaves linear-oblong. Calyx campanulate, c.  $1.3 \times 1.7 \text{ mm}$ , 5-veined; hairy outside, glabrous within; teeth more or less equal, ciliate, longest tooth c. 0.3 mm long, shortest 0.2 mm long, widest tooth c. 0.3 mm wide, narrowest tooth c. 0.2 mm wide; outer hairs 4-celled, c.  $430 \mu\text{m}$  long. Corolla 1.5 mm long; lower lip  $0.5 \times 0.5 \text{ mm}$ ; upper lip c. 1 mm across; central lobe c.  $0.4 \times 0.3 \text{ mm}$ ; a few hairs on the lobes. Filaments all inserted at a height of 0.5 mm in the tube, c. 1–1.3 mm long, exerted portion c. 0.3 mm. Style 2.2 mm long, stigma lobes c. 0.7 mm. Disc c. 0.2 mm long. Nutlets 4, c.  $1000 \times 700 \mu\text{m}$ , ellipsoid to ellipsoid-oblong, dark brown, spinulose.

**DISTRIBUTION.** Eastern India (Madras, Kaumbollan Hill).

**SPECIMENS EXAMINED.** *Feicher* 4724 (K), *Gamble* 20353 (K), *Wallich* 1547 (BM, K-syntypes), *Wight* 2130 (K), *Wight* 2533 (K), *Wight* 2534 (K).

**53. *Pogostemon salicifolius* (Dalzell ex Hook.f.) El Gazzar & L. Watson in *Taxon* 16: 187 (1967).**

Figs 11f, 31b.

*Dysophylla salicifolia* Dalzell ex Hook.f., *Fl. Brit. India* 4: 638 (1885).

Stem erect, solid, terete; hairs appressed, 2-celled, the cells more or less equal, c.  $425 \mu\text{m}$  long. Leaves in opposite pairs, linear to linear-lanceolate, c.  $35 \times 16 \text{ mm}$ , base cuneate, apex cuneate, margin shallowly dentate; hairs 2-celled, c.  $560 \mu\text{m}$  long, basal cell slightly longer than upper cell. Petiole c. 0.5 mm long; hairs 3-celled, c.  $440 \mu\text{m}$  long. Inflorescence a single terminal spike, c. 60 mm long, dense; hairs 2-celled, c.  $680 \mu\text{m}$  long. Calyx campanulate, c.  $2.5 \times 2.7 \text{ mm}$ , 5-veined; hairy outside, especially near the base, teeth hairy within; teeth ciliate, c.  $0.4\text{--}0.5 \text{ mm}$  long; outer hairs 3-celled, c.  $500 \mu\text{m}$  long. Corolla c. 3 mm long; lower lip c.  $1 \times 1 \text{ mm}$ ; upper lip c. 1.8 mm across; central lobe c.  $0.8 \times 0.4 \text{ mm}$ . Filaments all inserted at a height of 1.2 mm in the tube, c.  $3.9\text{--}4.2 \text{ mm}$  long, exerted portion

c. 2 mm; filaments all sparingly hairy towards the base. Style c. 5.2 mm long; stigma lobes c. 0.5 mm. Disc c. 3 mm long. Nutlets 4, c.  $700 \times 200 \mu\text{m}$ , oblong, very shiny dark brown, smooth.

**DISTRIBUTION.** Western India (Bombay, Maharashtra, Mahabaleshwar, Concan, Mahabaleh Hills).

**SPECIMENS EXAMINED.** *Dalzell* s.n. (K-holotype), *Hooker* s.n. (K), *Liam* s.n. in Herb. Hooker (K), *Townsend* 73/25 (K).

**54. *Pogostemon quadrifolius* (Benth.) Kuntze, *Rev. gen. pl.* 2: 530 (1891).**

Figs 11g, 31c.

*Mentha stellata* Roxb., *Hort. bengal.*: 44 (1814), nom. illegit.

*Dysophylla quadrifolia* Benth. in Wall., *Pl. asiat. rar.* 1: 30 (1830).

*D. velutina* Benth. in Wall., *Pl. asiat. rar.* 1: 30 (1830).

*D. rupestris* Dalzell in *Hooker's J. Bot.* 3: 120 (1851).

*Eusteralis quadrifolia* (Benth.) Panigrahi in *Phytologia* 32: 478 (1976).

*E. quadrifolia* (Benth.) Majumdar in *J. Bombay nat. Hist. Soc.* 74: 385 (1978, '1977').

Stem erect, solid, terete; hairs 3-celled, c.  $437 \mu\text{m}$  long. Leaves mostly in whorls of 4, sometimes in opposite pairs, lanceolate, c.  $70 \times 12 \text{ mm}$ , base cuneate, apex acute, margin serrate; hairs 4-celled, c.  $750 \mu\text{m}$  long. Petiole c. 4 mm long; hairs similar to those of stem. Inflorescence much branched, each branch terminated by a terminal spike, spike on main axis c. 120 mm long, dense; hairs 4-celled, c.  $750 \mu\text{m}$  long. Calyx campanulate, c.  $2 \times 2.7 \text{ mm}$ , 5-veined; hairy outside, glabrous within; teeth ciliate, c.  $0.4\text{--}0.5 \text{ mm}$  long,  $0.4\text{--}0.6 \text{ mm}$  wide at base; outer hairs 3-celled, c.  $310 \mu\text{m}$  long. Corolla up to 3.3 mm long; lower lip c.  $0.9 \times 0.9 \text{ mm}$ ; upper lip c. 2 mm across; central lobe  $0.8 \times 0.6 \text{ mm}$ ; lobes hairy. Filaments all inserted at a height of 1.4 mm in the tube, c.  $4.2\text{--}4.5 \text{ mm}$  long, exerted portion c. 2.6 mm; filaments equally hairy at the base. Style 4.5 mm long; stigma lobes unequal, c.  $0.9\text{--}1 \text{ mm}$ . Disc c. 0.3 mm long. Nutlets 3, c.  $500 \times 400 \mu\text{m}$ , ellipsoid-oblong, dark brown, spinulose.

**DISTRIBUTION.** Northern India (Khasia, Assam, Sambalpur) and Bangladesh (Chittagong), and also from Kerala (Malabar, Godavari Distr., Garo Hills) in southern India. In eastern Bangladesh it grows on sandy soils.

**SPECIMENS EXAMINED.** *Barber* 7115 (K), *Bourne* 3396 (K), *Clarke* 19782 (K), *Gamble* 6739A (K), *Gamble* 15964 (K), *Gamble* 15965 (K), *Griffiths* 205 (K), *Hooker* 1538 (K), *Hooker* 1539 (K), *Hooker* 1540 (K), *Monney* 2557 (K), *Parry* 937 (K), *Parry* 1040 (K), *Raza* 786 (K), *Roxburgh* s.n. (K-syntype).

Tahir *et al.* (1995) report a reticulate nutlet surface and a calyx only hairy on the teeth in material from Bangladesh.

**55. *Pogostemon micangensis* G. Taylor in *J. Bot., Lond.* 69 (Suppl. 2): 166 (1931).**

Figs 11j, 32c.

Aquatic herb with spreading caespitose rhizome; stem weak, terete, red-purple; hairs 4-celled, c.  $325 \mu\text{m}$  long. Leaves in opposite pairs, ovate,  $22 \times 9 \text{ mm}$ , base cuneate, apex acute, margin serrate; hairs 3-celled, c.  $200 \mu\text{m}$  long. Petiole 1 mm long; hairs 3-celled, c.  $200 \mu\text{m}$  long. Inflorescence a single terminal spike, c. 44 mm long, dense; hairs 2-celled, c.  $430 \mu\text{m}$  long. Calyx campanulate,  $3.8 \times 5.5 \text{ mm}$ , 10-veined; glabrous or with a few hairs outside, teeth and upper part of tube hairy within; teeth ciliate, c.  $0.4\text{--}1.2 \text{ mm}$  long,  $0.8\text{--}1.4 \text{ mm}$  wide at base; outer hairs 5-celled, c.  $580 \mu\text{m}$  long. Corolla up to 4.9 mm long, whitish violet; lower lip c.  $1.1 \times 1.4 \text{ mm}$ ; upper lip c. 1.7



mm across; central lobe  $0.8 \times 0.5$  mm, hairy. Filaments inserted at different heights, the lowest at a height of 2.3 mm in the tube; filaments *c.* 5.7–6.0 mm long, exerted portion *c.* 3.4 mm; filaments glabrous towards the base. Style *c.* 5.8 mm long; stigma lobes *c.* 0.7–1 mm. Disc *c.* 0.5 mm long. Nutlets 4, *c.*  $400 \times 300$   $\mu$ m, ellipsoid to ellipsoid-oblong, reticulate-foveate.

**DISTRIBUTION.** Angola (River Micango) and Cameroon. Found in the marshes of the river Micango.

**SPECIMENS EXAMINED.** *Gossweiler* 2545 (BM-isotype), *J. & A. Raynal* 12161 (BM).

*Gossweiler* 2545 has calyces which are 5, 6 & 7 toothed.

**56. *Pogostemon mutamba*** (Hiern) G. Taylor in *J. Bot., Lond.* **69** (Suppl. 2): 166 (1930).  
Figs 11i, 32b.

*Geniosporum mutamba* Hiern, *Cat. afr. pl.*: 854 (1900).

Amphibious perennial with a polycephalic rootstock; stem weak, angular; hairs 4-celled, *c.* 275  $\mu$ m long. Leaves in opposite pairs, elliptic to elliptic-oblong, soft-flaccid,  $90 \times 35$  mm, base rounded, apex acute, margin dentate; hairs 6-celled, *c.* 600  $\mu$ m long. Petiole 5 mm long; hairs 4-celled, 300  $\mu$ m long. Inflorescence a procumbent to ascending terminal spike, *c.* 60 mm long, with more than two lateral spikes, all spikes dense; hairs 4-celled, *c.* 680  $\mu$ m long. Calyx campanulate,  $2.5 \times 3.0$  mm, 5-veined; densely hairy outside, teeth hairy within; teeth ciliate, *c.* 0.5–0.7 mm long, *c.* 0.5–0.6 mm wide at base; outer hairs 5-celled, *c.* 430  $\mu$ m long. Corolla up to 5.6 mm long, whitish violet; lower lip *c.*  $1.9 \times 1.6$  mm; upper lip *c.* 2 mm across, hairy; central lobe *c.*  $1.1 \times 0.5$  mm. Filaments all inserted at a height of 2.8 mm in the tube, *c.* 5.0–5.7 mm, exerted portion *c.* 2.9 mm; filaments glabrous towards the base. Style *c.* 7 mm long; stigma lobes *c.* 0.7 mm, violet-purple. Disc *c.* 0.5 mm long. Nutlets 4, *c.*  $400 \times 300$   $\mu$ m, oblong, reticulate-foveate.

**DISTRIBUTION.** Angola (between Ganda and Caconda, Planalto, Benguela).

**ETHNOBOTANY.** *Pogostemon mutamba* is a source of starchy edible tubers.

**SPECIMENS EXAMINED.** *Gossweiler* 9668 (BM), *Welwitsch* 5496 (BM-syntype), *Welwitsch* 5590 (BM, K-syntypes).

**57. *Pogostemon tisserantii*** (Pellegr.) Bhatti & Ingr., **comb. nov.**  
Figs 11h, 32a.

*Dysophylla tisserantii* Pellegr. in *C. r. Ass. fr. Avanc. Sci.* **49**: 387 (1926).

Stem weak; hairs thin, whitish, 2-celled, *c.* 200  $\mu$ m long. Leaves in whorls of 4, deeply pinnatifid, *c.* 30 mm long; hairs sparse, 1-celled, *c.* 75  $\mu$ m long. Inflorescence spikes *c.* 70  $\mu$ m long, flowers in interrupted whorls. Calyx campanulate,  $2 \times 2.5$  mm; hairy outside and distinctly glandular, teeth hairy within; teeth ciliate, *c.* 0.6–0.7 mm long, *c.* 0.4–0.5 mm wide at base; outer hairs 4-celled, *c.* 250  $\mu$ m long. Corolla *c.* 2.2 mm long; lower lip *c.*  $0.8 \times 0.8$  mm; upper lip *c.* 1.7 mm across, hairy outside; central lobe *c.*  $0.5 \times 0.5$  mm. Filaments all inserted at a height of 0.6 mm in the tube, *c.* 3.1 mm long, exerted portion *c.* 1.5 mm; filaments glabrous at the base. Style *c.* 3.3 mm long; stigma lobes *c.* 0.7 mm. Disc *c.* 0.3 mm long. Nutlets 4, *c.*  $570 \times 400$   $\mu$ m, ovoid, somewhat cuneate at the base, reticulate-foveate.

**DISTRIBUTION.** Chad.

**SPECIMENS EXAMINED.** *Jacques* 1807 (K).

This is the only species of *Pogostemon* which has compound leaves.

**IIIb. Section VERTICILLATUS (Benth.) Bhatti & Ingr., comb. nov.**

*Dysophylla* Blume, pro parte (1826), *Dysophylla* section *Verticillatae* Benth. (1832), *Eusteralis* Raf. (1847), *Dysophylla* subgenus *Chotekia* Keng, pro parte (1927).

Leaves usually linear to linear-lanceolate (*P. trinervis* orbicular), sessile, truncate, rounded or cuneate), more than two leaves at each node (*P. andersonii* two leaves).

**58. *Pogostemon lythroides*** (Diels) Press in *Bull. Br. Mus. nat. Hist. (Bot.)* **10**: 74 (1982).  
Figs 12a, 33a.

*Dysophylla lythroides* Diels in *Notizbl. Bot. Gart. Mus. Berl.* **9**: 1031 (1926).

Stem terete, weak, glabrous. Leaves in whorls of 4, linear, violet above, *c.*  $88 \times 10$  mm, base truncate, apex acute, margin distantly serrate, revolute, lamina with midvein sparsely hairy abaxially, lateral veins obscure on adaxial surface but distinct on abaxial surface; hairs 2-celled, *c.* 180  $\mu$ m long. Inflorescence a single terminal spike *c.* 16 mm long, glabrous. Floral leaves claviform, linear to linear-lanceolate. Calyx campanulate, *c.*  $28 \times 35$  mm; outside densely hairy throughout, teeth hairy within; teeth ciliate, *c.* 0.9–1.1 mm long, *c.* 0.5–0.7 mm wide at base; outer hairs 3-celled, *c.* 560  $\mu$ m long. Corolla *c.* 4 mm long; lower lip *c.*  $1.4 \times 1.4$  mm; upper lip *c.* 2.8 mm across; central lobe *c.*  $0.7 \times 0.5$  mm; upper and lower lip hairy outside. Filaments all inserted at a height of 1.5 mm in the tube, *c.* 4.0–4.5 mm long, exerted portion *c.* 2.2 mm; filaments glabrous at the base. Style *c.* 5.5 mm long; stigma lobes 0.6–0.8 mm long. Disc *c.* 0.4 mm long. Nutlets 4, *c.*  $400 \times 300$   $\mu$ m, oblong, reticulate-foveate.

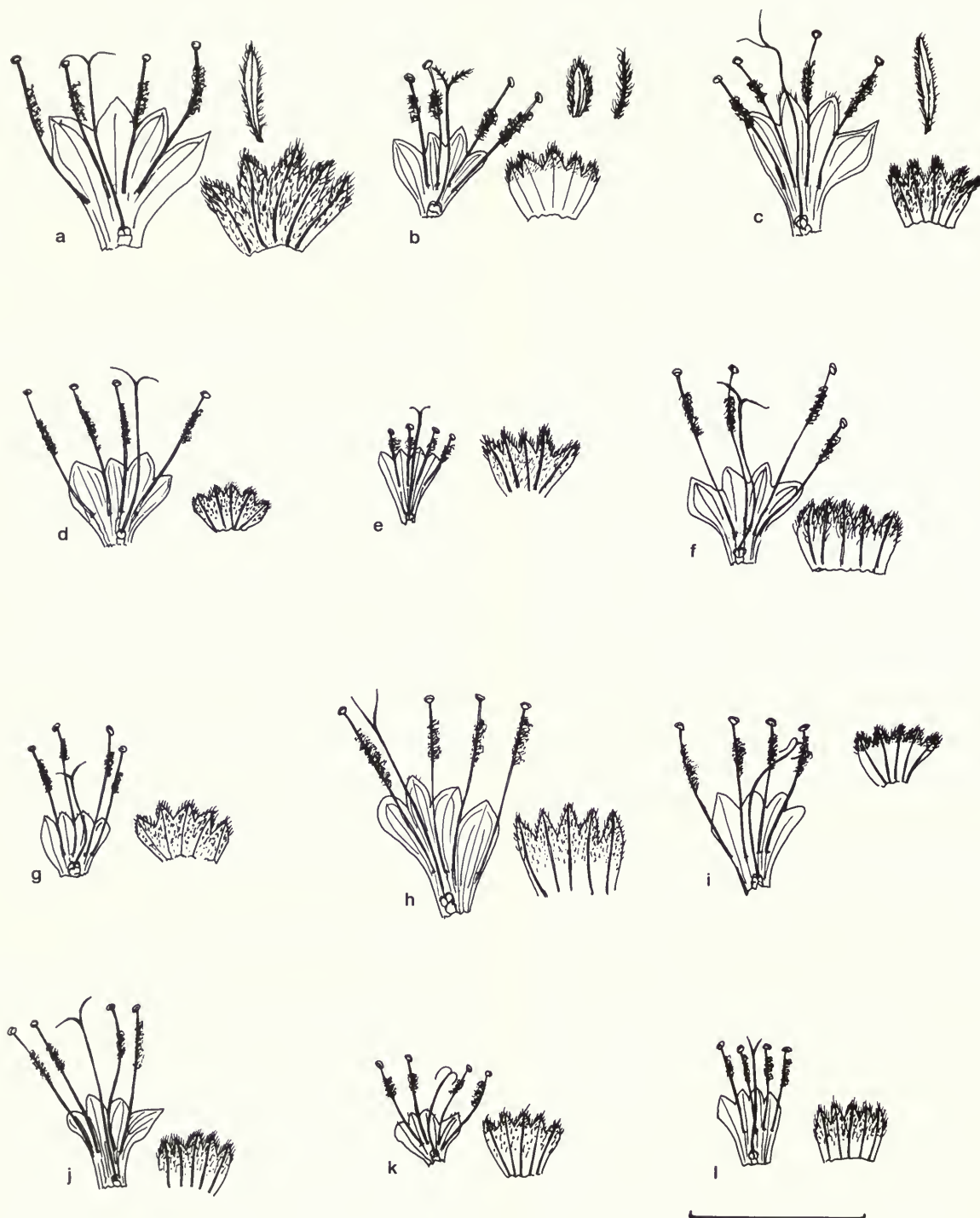
**DISTRIBUTION.** Widespread throughout south Asia: India (Sambalpur, Khasia), Sri Lanka, Malaysia, Sulawesi, Papua New Guinea, China (Yunnan).

**SPECIMENS EXAMINED.** *Cramer* 3996 (K), *Cramer* 4902 (K), *Cramer* 5084 (K), *Duthie* 9698 (K), *Fan & Li* 563 (BM), *Flenley* 2104 (K), *Griffith* 1544 (K), *Hartley* 9689 (K), *Mooney* 2139 (K), *Mooney* 3226 (K), *Steenis* 1260 (K).

**59. *Pogostemon ciliatus*** Bhatti & Ingr., **sp. nov.**  
Figs 12b, 33b.

Herba villosa. Caules solidi quadrangulati, pilibus bicellularibus *c.* 750  $\mu$ m: in quoque nodus 4 folia lineares, verticillatae, ad  $40 \times 3$  mm; cuneati et acutifolia, margine integre, pilibus bicellularibus, *c.* 560  $\mu$ m long. Inflorescentia terminalis ad *c.* 70 mm longa, pilibus bicellularibus *c.* 750  $\mu$ m long. Calyx campanulatus, *c.*  $1.8 \times 2.5$  mm; dentibus *c.* 0.4–0.5 mm, partibus interioribus pilibus, margine ciliato; in partibus exterioribus villosibus, bicellularibus, *c.* 750  $\mu$ m. Corolla *c.* 2.5 mm; labio inferiori  $1 \times 1$  mm; labio superiori 1.5 mm lato; lobis superiori  $0.6 \times 0.6$  mm; labio superiori et inferiori ciliati. Stamina quatuor filamentis affixus ad 0.9 mm in tubo; filaments 3.0–3.3 mm; partibus exsertibus *c.* 1.7 mm. Styli *c.* 3.4 mm; stigmatibus lobibus *c.* 0.6 mm, hirsutibus. Disc non lobatus, 0.4 mm. Nuculae 4, *c.*  $600 \times 400$   $\mu$ m, oblongae, granulae, valde flexuosa.

**TYPE.** New Guinea (expeditie 1954–55), Netherland, New Guinea and Kebar valley, *c.* 100 km west of Manokwari, 2 November 1954, *Royen* 3967 (K!-holotype).



**Fig. 12** Dissected corollas, calyces and bracts, showing inner surface. *Pogostemon* subgenus *Dysophyllus* section *Dysophyllus*: (a) *P. lythroides*, (b) *P. ciliatus*, (c) *P. linearis*, (d) *P. pentagonus*, (e) *P. andersonii*, (f) *P. cruciatus*, (g) *P. sampsonii*, (h) *P. yatabeanus*, (i) *P. faurei*, (j) *P. peguanus*, (k) *P. koehneanus*, (l) *P. crassicaulis*. Scale bar 5 mm.



Stem solid, angular, villous; hairs 2-celled, c. 750 µm long. Leaves in whorls of 4, linear, 40 × 3 mm, base cuneate, apex acute, margin entire; hairs 2-celled, c. 560 µm long. Inflorescence a single terminal spike, c. 70 mm long; hairs 2-celled, c. 750 µm long. Calyx campanulate, c. 1.8 × 2.5 mm; hairy outside, teeth hairy within; teeth ciliate, c. 0.4–0.5 mm long, 0.4–0.5 mm wide at the base; outer hairs villous, 2-celled, c. 750 µm long. Corolla c. 2.5 mm long; lower lip 1 × 1 mm; upper lip 1.5 mm across; central lobe 0.6 × 0.6 mm; upper and lower lip ciliate. Filaments all inserted at a height of 0.9 mm in the tube, 3.0–3.3 mm long, exerted portion c. 1.7 mm; filaments equally hairy towards the base. Style c. 3.4 mm long; stigma lobes c. 0.6 mm, hairy. Disc 0.4 mm long. Nutlets 4, c. 600 × 400 µm, oblong, brown, granulate with 'zig-zag' channels.

**DISTRIBUTION.** New Guinea. Growing in meadows among tall grasses; fairly common.

*Pogostemon ciliatus* is distinct in having hairy/ciliate stigma lobes, the upper and lower lips of the corolla ciliate, and a nutlet surface with zigzag channels (not spinulose).

60. *Pogostemon linearis* (Benth.) Kuntze, *Rev. gen. pl.* 2: 529 (1891).

Figs 12c, 33c.

*Dysophylla linearis* Benth. in A. DC., *Prodr.* 12: 157 (1848).

*Eusteralis linearis* (Benth.) Panigrahi in *Phytologia* 32: 476 (1976).

*E. linearis* (Benth.) Majumdar in *J. Bombay nat. Hist. Soc.* 74: 385 (1978, '1977').

Stem erect or procumbent and rooting at the nodes, weak, reddish brown, glabrous or with a few hairs towards the inflorescence. Leaves in whorls of 4, linear to linear-lanceolate, c. 50 × 5 mm, base acute, apex bluntly acute, margin distantly dentate, lamina sparsely hairy, the abaxial surface with sunken glands; hairs 2-celled, c. 120 µm long. Inflorescence a single terminal spike, c. 60 mm long; hairs 2-celled, c. 250 µm long. Floral bracts oblong, brownish towards the tip. Calyx infundibular, c. 2 × 2.8 mm; densely hairy outside, especially at the teeth tips, with conspicuous brown glands, glabrous within; teeth ciliate, c. 0.5–0.9 mm long, c. 0.4–0.6 mm wide at base; outer hairs 4-celled, c. 430 µm long. Corolla c. 4.2 mm long; lower lip c. 1.3 × 1.3 mm; upper lip c. 2.5 mm across; central lobe c. 1.1 × 0.7 mm; upper and lower lip hairy outside. Filaments all inserted at a height of 1.5 mm in the tube, c. 3–4 mm long, exerted portion c. 1.3 mm; two filaments hairy. Style c. 5.5 mm long; stigma lobes c. 0.8–1.0 mm. Disc c. 0.6 mm long, shallowly lobed. Mature nutlets 1, c. 1000 × 800 µm, ellipsoid to ellipsoid-oblong, tan, reticulate-foveate.

**DISTRIBUTION.** Western China (Dirang-Dzong, Yunnan), Bhutan.

**SPECIMENS EXAMINED.** *Bodinier* s.n. (K), *Clarke* 45731 (BM), *Forrest* 11747 (BM, K), *Forrest* 16059 (K), *Forrest* 25146 (K), *Henry* 12628 (K), *Kingdon-Ward* 14260 (BM).

61. *Pogostemon pentagonus* (C.B. Clarke ex Hook.f.) Kuntze, *Rev. gen. pl.* 2: 529 (1891).

Figs 12d, 34a.

*Dysophylla pentagona* C.B. Clarke ex Hook.f., *Fl. Brit. India* 4: 641 (1885).

*Eusteralis pentagona* (C.B. Clarke ex Hook.f.) Panigrahi in *Phytologia* 32: 477 (1976).

*E. pentagona* (C.B. Clarke ex Hook.f.) Majumdar in *J. Bombay nat. Hist. Soc.* 74: 386 (1978, '1977').

Stem procumbent, solid, terete, glabrous. Leaves in whorls of 4,

linear, c. 20 × 2 mm, base truncate, apex bluntly acute to obtuse, margin entire, revolute, lamina glabrous. Inflorescence a single terminal spike, c. 30 mm long, with glandular and eglandular hairs; hairs 3-celled, c. 250 µm long. Calyx campanulate, c. 1.2 × 2 mm; sparsely hairy outside, glabrous within; teeth ciliate, c. 0.3–0.5 mm long, c. 0.4–0.5 mm wide at base, incurved in fruit, closing the mouth of the tube; outer hairs 3-celled, c. 250 µm long, basal cell with dark contents, glands conspicuous. Corolla c. 2.5 mm long; upper lip c. 1.5 mm across, lower lip c. 0.7 × 1 mm; central lobe c. 0.7 × 0.9 mm wide at base; upper and lower lip with a ring of hairs outside. Filaments all inserted at a height of 0.8 mm height in the tube, c. 3.5–4 mm long, exerted portion c. 2.2 mm; filaments glabrous at the base. Style 3.5 mm long, bulbous at base; stigma lobes unequal, c. 0.7 and 1 mm. Nutlets 4, c. 700 × 400 µm, oblong, 4-angled, light brown.

**DISTRIBUTION.** India (Chota Nagar, Sambalpur, Bihar, and Orissa) and Thailand (Dai Thai).

**SPECIMENS EXAMINED.** *Clarke* 20438 (BM, K-isotypes), *Garrett* 56 (BM, K), *Kerr* 1465 (BM, K), *Mooney* 1854 (K).

62. *Pogostemon andersonii* (Prain) Press in *Bull. Br. Mus. nat. Hist. (Bot.)* 10: 71 (1982).

Figs 12e, 34b.

*Dysophylla andersonii* Prain in *J. Asiat. Soc. Beng.* 59: 298 (1891).

*Eusteralis andersonii* (Prain) Majumdar in *J. Bombay nat. Hist. Soc.* 74: 386 (1978, '1977').

Stem erect, terete, villous; hairs 3-celled with longer apical cell, c. 350 µm long. Leaves in opposite pairs or in whorls of 3 or more, sessile, lanceolate, c. 35 × 8 mm, base cuneate to truncate, apex acute, margin distantly dentate, lamina villous; hairs up to 3-celled with long apical cell, swollen at junction between cells, c. 440 µm long. Inflorescence a single terminal spike c. 15 mm long, dense; hairs 3-celled, c. 350 µm long. Floral leaves linear to linear-lanceolate. Calyx campanulate, c. 1.8 × 2.5 mm; 5-veined; villous outside, teeth with a few hairs within; teeth more or less oblong with bluntly acute apex, ciliate, c. 0.6–0.8 mm long, 0.4–0.6 mm wide at base; outer hairs villous, 4-celled, c. 370 µm long. Corolla c. 2.4 mm long; lower lip 0.5 × 0.5 mm; upper lip c. 1.1 mm across; central lobe c. 0.5 × 0.4 mm; upper and lower lip hairy outside. Filaments all inserted at a height of 1.2 mm in the tube, c. 1.5–1.8 mm long, exerted portion c. 0.8 mm; filaments glabrous at the base. Style c. 2.5 mm long; stigma lobes c. 0.3 mm. Disc c. 0.2 mm long. Nutlets 4, c. 360 × 230 µm, oblong, dark brown, reticulate-foveate.

**DISTRIBUTION.** Northeastern India (Sikkim).

**SPECIMENS EXAMINED.** *Anderson* s.n. (K-holotype).

63. *Pogostemon cruciatus* (Benth.) Kuntze, *Rev. gen. pl.* 2: 529 (1891).

Figs 12f, 34c.

*Dysophylla cruciata* Benth. in Wall., *Pl. asiat. rar.* 1: 30 (1830).

*Eusteralis cruciata* (Benth.) Panigrahi in *Phytologia* 32: 478 (1976), non *Dysophylla cruciata* sensu Hemsl. ex F.B. Forbes & Hemsl. (1890), non *D. cruciata* sensu Dunn (1915).

*E. cruciata* (Benth.) Majumdar in *J. Bombay nat. Hist. Soc.* 74: 385 (1978, '1977').

Stem erect, solid, terete, hirsute; hairs 5-celled, c. 1200 µm long. Leaves in whorls of 4–5, linear, c. 30 × 4 mm, base cuneate, apex obtuse to bluntly acute, margin entire, revolute; hairs 4-celled, c. 1000 µm long. Inflorescence a single terminal spike, c. 100 mm

long; hairs stalked, 5-celled, c. 1200  $\mu\text{m}$  long. Calyx campanulate, c.  $1.8 \times 2.7$  mm; tube and teeth very hairy outside, teeth hairy within; teeth ciliate, c. 0.5–0.7 mm long, c. 0.4–0.6 mm wide at base; outer hairs 5-celled, c. 750  $\mu\text{m}$  long. Corolla up to c. 2.7 mm long; lower lip c.  $1 \times 1$  mm; upper lip c. 1.8 mm across; central lobe c.  $0.8 \times 0.5$  mm; upper and lower lip hairy outside. Filaments all inserted at a height of c. 1.1 mm in the tube, c. 3.6–4.6 mm long, exerted portion c. 3 mm; filaments hairy towards the base. Style c. 4 mm long; stigma lobes c. 0.7 mm. Disc c. 0.2 mm long. Nutlets 4, c.  $600 \times 400$   $\mu\text{m}$ , oblong, basal part protuberant, light brown, smooth.

**DISTRIBUTION.** Widespread from eastern India and the Himalayas (Orissa, Sambalpur, Nepal, Assam, Chota Nagpur, Nagaland, Manipur), China (Yunnan) to Thailand.

**SPECIMENS EXAMINED.** Clarke 18059 (BM), Clarke 34312A (K), Forrest 25140 (K), Hensen, Seidenfaden & Smitinand 10824 (K), Hensen, Seidenfaden & Smitinand 11008 (K), Meebold 6002 (K), Meebold 7612 (K), Mooney 1855 (K), Mooney 4234 (K), Strachey & Winterbottom 1541 (K-isotypes).

64. **Pogostemon sampsonii** (Hance) Press in *Bull. Br. Mus. nat. Hist. (Bot.)* 10: 74 (1982).  
Figs 12g, 35a.

*Dysophylla sampsonii* Hance in *Annls Sci. nat.* 5: 284 (1866).  
*Eusteralis sampsonii* (Hance) Panigrahi in *Phytologia* 32: 478 (1976).

Stem solid, terete, sparsely hairy; hairs 3-celled, c. 250  $\mu\text{m}$  long, violet. Leaves in whorls of 3, linear-lanceolate, c.  $20 \times 5$  mm, base truncate, apex obtuse to bluntly acute, margin serrate, lamina glabrous. Inflorescence a single terminal spike, c. 20 mm long, dense, stalk glabrous. Floral leaves elliptic-ovate. Calyx campanulate, c.  $1.5 \times 2.4$  mm; tube and teeth hairy outside; teeth ciliate, c. 0.4–0.5 mm long, c. 0.5–0.6 mm wide at base; outer hairs 2-celled, c. 180  $\mu\text{m}$  long. Corolla c. 1.7 mm long; lower lip c.  $0.6 \times 0.6$  mm; upper lip c. 1.6 mm across; central lobe  $0.5 \times 0.5$  mm; upper and lower lip hairy outside. Filaments all inserted at a height of 0.8 mm in the tube, inner pair c. 3.3 mm long, outer pair 2.8 mm long, exerted portion c. 2.4 mm; filaments glabrous at the base. Style c. 3.5 mm long; stigma lobes c. 0.4–0.5 mm. Disc 0.2 mm long. Nutlets 4, c.  $640 \times 450$   $\mu\text{m}$ , oblong, attachment point protruded, reticulate-foveate.

**DISTRIBUTION** China.

**ETHNOBOTANY.** *Pogostemon sampsonii* has been used to poison flies in China (Von Reis, 1973).

**SPECIMENS EXAMINED.** Hance 10946 (BM, K-isotypes).

65. **Pogostemon yatabeanus** (Makino) Press in *Bull. Br. Mus. nat. Hist. (Bot.)* 10: 74 (1982).  
Figs 12h, 35b.

*Dysophylla yatabeana* Makino in *Bot. Mag., Tokyo* 1: 55 (1898).  
*Eusteralis yatabeana* (Makino) Panigrahi in *Phytologia* 32: 478 (1976).  
*E. yatabeana* (Makino) Murata in *Acta phytotax. geobot. Kyoto* 33: 370 (1982).

Stem solid, terete, glabrous. Leaves in whorls of 3, linear, c.  $80 \times 5$  mm, base truncate, apex acute, margin distantly serrate, lamina sparsely hairy and with golden glands; hairs 2-celled, c. 150  $\mu\text{m}$  long. Inflorescence a single terminal spike, c. 50 mm long, stalk glabrous. Floral leaves linear. Calyx campanulate, c. 2.5 mm long; outside with many hairs and glands, teeth hairy within; teeth ciliate, c. 0.5–0.7 mm long; outer hairs 3-celled, c. 370  $\mu\text{m}$  long. Corolla c.

4 mm long; lower lip c.  $1.2 \times 1.2$  mm; upper lip c. 2 mm across; central lobe c.  $0.9 \times 0.7$  mm; upper and lower lip hairy outside. Filaments all inserted at a height of 1.5 mm in the tube, c. 4.4–5.0 mm long, exerted portion c. 2.5 mm; filaments all glabrous at the base. Style c. 5.5 mm long; stigma lobes 0.8–1 mm long. Disc c. 0.4 mm long. Nutlets 4, c.  $900 \times 600$   $\mu\text{m}$ , oblong, light brown, reticulate-foveate with small depression at the base.

**DISTRIBUTION.** Japan (Honshu, Shikoku, Kyushu) and Korea.

**SPECIMEN EXAMINED.** *Midutoranowo* s.n. (K-isotype).

66. **Pogostemon faurei** (H. Lév.) Press in *Bull. Br. Mus. nat. Hist. (Bot.)* 10: 73 (1982).  
Figs 12i, 35c.

*Dysophylla faurei* H. Lév. in *Reprium Spec. nov. Regni veg.* 9: 248 (1911).

Stem weak, glabrous. Leaves in whorls of 4, linear, c.  $24 \times 3$  mm, base cuneate, apex acute, margin dentate, lamina glabrous. Inflorescence a single terminal spike, c. 25 mm long; hairs 3-celled, c. 250  $\mu\text{m}$  long. Calyx campanulate,  $2 \times 2.5$  mm; glabrous or sparsely hairy outside with very fine hairs, teeth hairy within; teeth ciliate, c. 0.5 mm long, widest tooth c. 0.8 mm wide at base, narrowest tooth c. 0.4 mm wide at base; outer hairs 1-celled, c. 100  $\mu\text{m}$  long. Corolla up to 3.3 mm long; lower lip  $1 \times 1$  mm; upper lip c. 2 mm across; central lobe c.  $0.6 \times 0.5$  mm. Filaments all inserted at a height of c. 1.4 mm in the tube, c. 3.5–3.8 mm long, exerted portion c. 1.9 mm; filaments glabrous at the base. Style c. 4.5 mm long; stigma lobes c. 1 mm long. Disc c. 0.3 mm long. Nutlets 4, c.  $410 \times 305$   $\mu\text{m}$ , oblong, reticulate-punctate.

**DISTRIBUTION.** Korea. In rice paddies.

**SPECIMENS EXAMINED.** Esquiz 199 (E), Faurie 760 (E-holotype), Taquet 1178 (E).

67. **Pogostemon peguanus** (Prain) Press in *Bull. Br. Mus. nat. Hist. (Bot.)* 10: 74 (1982).  
Figs 12j, 36a.

*Dysophylla peguana* Prain in *J. Asiat. Soc. Beng.* 59: 298 (1891).

Stem erect, 4-angled, weak; hairs appressed, 1-celled, c. 370  $\mu\text{m}$  long. Leaves in whorls of 4, linear, c.  $60 \times 3$  mm, base truncate, apex bluntly acute to obtuse, margin entire, revolute, lamina with appressed hairs; hairs 1-celled, c. 400  $\mu\text{m}$  long. Inflorescence a single terminal spike, c. 80 mm long; stalk with glandular and eglandular hairs; eglandular hairs 1-celled, c. 400  $\mu\text{m}$  long, glandular hairs 3-celled, c. 250  $\mu\text{m}$  long. Calyx campanulate, c.  $1.8 \times 2.4$  mm; hairy outside with glandular and eglandular hairs, teeth hairy within, the hairs unicellular; teeth ciliate, c. 0.4–0.6 mm long, 0.4–0.6 mm wide at base; outer eglandular hairs 1-celled, c. 400  $\mu\text{m}$  long, glandular hairs 3-celled, c. 250  $\mu\text{m}$  long. Corolla c. 2.5 mm long; lower lip  $1 \times 0.8$  mm; upper lip c. 1.5 mm across; central lobe  $0.7 \times 0.5$  mm; upper and lower lip hairy outside. Filaments all inserted at a height of 1 mm in the tube, c. 3.5–3.8 mm long, exerted portion c. 2.3 mm; filament glabrous at the base. Style 4.5 mm long; stigma lobes c. 0.8–0.9 mm. Disc c. 1 mm long. Nutlets 4, c.  $500 \times 300$   $\mu\text{m}$ , oblong with protuberant base, light brown, smooth.

**DISTRIBUTION.** Southeastern Asia in Burma (Pegu, Lahamauge) and Thailand (Pak Zong Chai).

**SPECIMENS EXAMINED.** Kunz 2401 (K-syntype), Kunz 2405 (K-syntype), Lacey 2899 (K), Collector unknown 8123 (K).



68. ***Pogostemon koehneanus*** (Muschl.) Press in *Bull. Br. Mus. nat. Hist. (Bot.)* **10**: 74 (1982).  
Figs 12k, 36b.

*Dysophylla koehneana* Muschl. in *Reprium nov. Spec. Regni veg.* **4**: 269 (1907).

Stem weak; hairs 1-celled, *c.* 430  $\mu$ m long. Leaves in whorls of 3, lanceolate, *c.* 22  $\times$  4 mm, base cuneate, apex acute, margin serrate; hairs 1-celled, *c.* 310  $\mu$ m long. Inflorescence a single terminal spike, *c.* 50 mm long; hairs 1-celled, *c.* 430  $\mu$ m long. Calyx campanulate, *c.* 1.5  $\times$  2.3 mm; hairy outside, teeth hairy within; teeth ciliate, *c.* 0.5  $\times$  0.5 mm, incurved in fruit; outer hairs 2-celled, *c.* 370  $\mu$ m long, basal cell swollen, glands obvious. Corolla *c.* 1.7 mm long; lower lip 0.7  $\times$  0.7 mm; upper lip *c.* 1.3 mm across; central lobe 0.5  $\times$  0.4 mm; lips sparsely hairy. Filaments all inserted at a height of 0.7 mm in the tube, *c.* 2.4–2.7 mm long, exerted portion *c.* 1.4 mm; filaments glabrous towards the base. Style *c.* 2.4 mm long; stigma lobes *c.* 0.5 mm. Disc *c.* 0.2 mm long. Nutlets 4, *c.* 500  $\times$  300  $\mu$ m, oblong with pointed base, brown, shiny, smooth-lineate.

DISTRIBUTION. Thailand.

SPECIMENS EXAMINED. Clarke 25 (K), Hosseus 704 (BM-isotype).

69. ***Pogostemon crassicaulis*** (Benth.) Press in *Bull. Br. Mus. nat. Hist. (Bot.)* **10**: 73 (1982).  
Figs 12l, 36c.

*Dysophylla crassicaulis* Benth. in Wall., *Pl. asiat. rar.* **1**: 30 (1830).  
*Eusteralis crassicaulis* (Benth.) Panigrahi in *Phytologia* **32**: 476 (1976).

Annual herb; stem up to 40 cm, erect, solid, terete, rooting at the nodes, glabrous. Leaves in whorls of 3–5, linear, *c.* 30  $\times$  6 mm, base cuneate, apex acute, margin dentate, lamina brick red, sparsely hairy; hairs 2-celled, *c.* 250  $\mu$ m long. Inflorescence branches terminating in a single spike, spike on main axis *c.* 80 mm long, lateral spikes up to 40 mm long, stalk with glandular and eglandular hairs; hairs up to 3-celled, *c.* 300  $\mu$ m long. Calyx campanulate, *c.* 1.5  $\times$  2 mm; hairy outside with glandular and eglandular hairs, teeth hairy within; teeth ciliate, *c.* 0.5–0.7 mm long, *c.* 0.4–0.6 mm wide; outer eglandular hairs 2–4 celled, *c.* 250  $\mu$ m long, basal cell of glandular hairs swollen. Corolla *c.* 2.2 mm long, violet; lower lip 0.5  $\times$  0.5 mm; upper lip *c.* 1.2 mm across; central lobe *c.* 0.5  $\times$  0.3 mm; upper lip hairy outside. Filaments all inserted at a height of *c.* 1 mm in the tube, *c.* 2.0–2.4 mm long, exerted portion *c.* 1.2 mm; filaments glabrous at base. Style *c.* 3 mm long; stigma lobes *c.* 0.4 mm. Disc *c.* 0.2 mm long. Nutlets 4, *c.* 800  $\times$  300  $\mu$ m, oblong, basal part protuberant, brown, shiny, the surface more or less undulate.

DISTRIBUTION. Bangladesh (Sylhet), India (Allahabad, Baharaich, Motipur), and southeastern Asia to Vietnam. Rooting in the black mud of swamps in roadside ditches.

SPECIMENS EXAMINED. Couder s.n. (K), Panigrahi 6588 (E), Squires 249 (K), Wallich 1545 (BM, K-isotypes).

70. ***Pogostemon verticillatus*** (Roxb.) Bhatti & Ingr., **comb. nov.**  
Figs 13a, 37a.

*Mentha verticillata* Roxb., *Hort. Bengal.*: 44 (1814).

*Dysophylla verticillata* (Roxb.) Benth. in Wall., *Pl. asiat. rar.* **1**: 30 (1830), pro parte.

*D. ramosissima* Benth. in Wall., *Pl. asiat. rar.* **1**: 30 (1830).

*D. benthamiana* Hance in *Ann. Sc. Nat.* **V**, **5**: 234 (1866), pro parte.

*Pogostemon benthamianum* (Hance) Kuntze, *Rev. gen. pl.* **2**: 530 (1891).

Aquatic herb; stem angular, weak, few hairs at nodes and towards the inflorescence; hairs 3-celled, *c.* 280  $\mu$ m long. Leaves in whorls of up to 6, linear, 50  $\times$  2 mm, base truncate, apex acute, margin dentate, lamina glabrous, with golden glands sunken in the abaxial surface, adaxial surface covered with a white crystalline powder. Inflorescence a terminal spike, 60–160 mm long, the main axis sometimes shorter than the branches, with more than two lateral spikes; hairs on stalk few, 3-celled, *c.* 287  $\mu$ m long. Calyx infundibular, *c.* 1.2  $\times$  1.7 mm; densely hairy throughout outside with relatively stout hairs and round glands also present, glabrous within; teeth ciliate, *c.* 0.4  $\times$  0.4 mm, spreading; outer hairs 2-celled, *c.* 200  $\mu$ m long, basal cell glandular. Corolla up to 1.5 mm long; lower lip 0.5  $\times$  0.6 mm, few hairs outside; upper lip *c.* 1 mm across, ciliate at margin, few hairs on outer surface; central lobe 0.5  $\times$  0.5 mm. Filaments all inserted at a height of 0.6 mm in the tube, *c.* 1.5 mm long, exerted portion *c.* 0.6 mm; filaments equally hairy towards the base. Style *c.* 2 mm long; stigma lobes 0.4–0.5 mm. Disc *c.* 0.2 mm long. Nutlets 4, *c.* 548  $\times$  419  $\mu$ m, ellipsoid to ellipsoid-oblong, light brown, granular.

DISTRIBUTION. Bangladesh (Sylhet, Chutia Nagpur), India, and China (Canton). In pools. According to Bentham (1848: 157) it is also found in southeast Asia, the Philippines, and Australia.

ETHNOBOTANY. Vernacular name 'Pansinga baha'. The roots are used for the female complaint 'Sitka'. Grows on the edges of terraces.

SPECIMENS EXAMINED. Sampson 443 (E), Sampson s.n. (K), Sinclair 3831 (E), Watt 9861 (E), 24–8–1887. s.n. (K), Wallich 1543 (K-synotype), Wallich 1544 (BM, K-syntypes).

71. ***Pogostemon pumilus*** (Graham) Press in *Bull. Br. Mus. nat. Hist. (Bot.)* **10**: 74 (1982).  
Figs 13b, 37b.

*Mentha pumila* Graham in *Edinb. New phil. J.* **4**: 393 (1828).

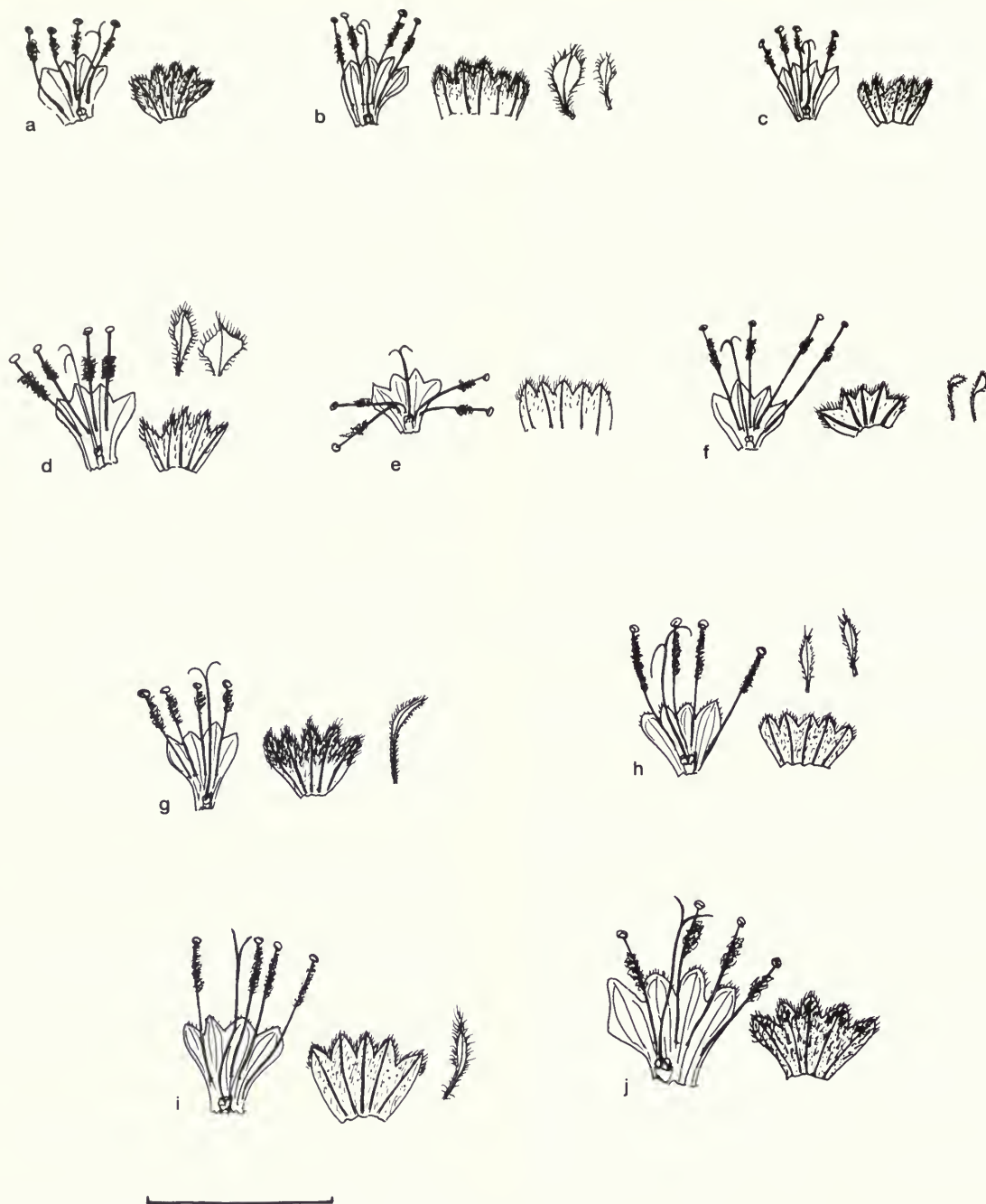
*Dysophylla pumila* (Graham) Benth. in Wall., *Pl. asiat. rar.* **1**: 30 (1830).

*Eusteralis pumila* (Graham) Panigrahi in *Phytologia* **32**: 477 (1976).  
*E. pumila* (Graham) Majumdar in *J. Bombay nat. Hist. Soc.* **74**: 385 (1978, '1977').

Stem erect, terete, weak, glabrous. Leaves in whorls of 4, linear to linear-lanceolate, *c.* 20  $\times$  3 mm, base truncate, apex acute, margin serrate, lamina glabrous. Inflorescence a single terminal spike up to 15 mm long, glabrous; floral leaves clavate, *c.* 1.7  $\times$  0.7 mm; bracts spatulate, up to 1 mm long, hairy at margin. Calyx campanulate, *c.* 1.6  $\times$  2.5 mm; glabrous within, hairy outside, mainly on the teeth; teeth ciliate, *c.* 0.4–0.5 mm long, *c.* 0.4–0.5 mm wide at base; outer hairs 2–3-celled, *c.* 200  $\mu$ m long, some glandular with dark basal cell. Corolla *c.* 0.8 mm long; lower lip *c.* 0.5  $\times$  0.5 mm; upper lip *c.* 1.2 mm across; central lobe *c.* 0.4  $\times$  0.5 mm; upper lip hairy outside. Filaments all inserted at a height of 0.9 mm in the tube, *c.* 1.7–2 mm long, exerted portion *c.* 1.1 mm; filaments glabrous towards the base. Style *c.* 2.5 mm long; stigma lobes *c.* 0.2–0.4 mm. Disc *c.* 0.2 mm long. Nutlets 4, *c.* 500  $\times$  400  $\mu$ m; oblong with protuberant base, brown, reticulate-punctate.

DISTRIBUTION. Nepal to Bangladesh.

SPECIMENS EXAMINED. Stone s.n. (E-isotypes), Wallich 1546 (E, K).



**Fig. 13** Dissected corollas, calyces and bracts, showing inner surface. *Pogostemon* subgenus *Dysophyllus* section *Verticillatus*: (a) *P. verticillatus*, (b) *P. pumilus*, (c) *P. trinervis*, (d) *P. helferi*, (e) *P. pressii*, (f) *P. stocksii*, (g) *P. erectus*, (h) *P. stellatus*, (i) *P. deccanensis*, (j) *P. aquaticus*. Scale bar 5 mm.

72. ***Pogostemon trinervis*** Chermisr. ex Press in *Bull. Br. Mus. nat. Hist. (Bot.)* 10: 74 (1982).

Figs 13c, 37c.

Stem erect, thin; hairs 2-celled, *c.* 180  $\mu$ m long, apical cell sometimes hook-shaped. Leaves in whorls of 3, more or less orbicular, *c.* 7  $\times$  5 mm, base rounded, apex obtuse, margin dentate, lamina with short stiff hairs on both sides; hairs 2-celled, *c.* 180  $\mu$ m long. Inflorescence branches terminated by a single spike, spike on main axis *c.* 20 mm long, stalk with glandular and eglandular hairs; hairs 2-celled, *c.* 250  $\mu$ m long. Calyx campanulate, 1.5  $\times$  2 mm, very hairy outside, teeth hairy within; teeth ciliate, *c.* 0.5 mm long, 0.4–0.5 mm

wide at base; outer hairs 2-celled, *c.* 500  $\mu$ m long, glandular or eglandular. Corolla *c.* 1.5 mm long; lower lip *c.* 0.5  $\times$  0.5 mm; upper lip *c.* 1.1 mm across; central lobe 0.4  $\times$  0.4 mm. Filaments all inserted at a height of 0.7 mm in the tube, three filaments *c.* 1.5–1.7 mm long, exerted portion *c.* 1.1 mm; filaments glabrous at the base. Style *c.* 1.7 mm long; stigma lobes *c.* 0.4 mm. Disc 0.3 mm long. Nutlets 4, *c.* 600  $\times$  400  $\mu$ m, oblong with protuberant base, tan, shiny, smooth.

**DISTRIBUTION.** Thailand (Hui-Taleng, Korat, Pak-tang-chai).

**SPECIMENS EXAMINED.** *Alam* 8115 (K), *Put* 2223 (BM-holotype).



73. ***Pogostemon helferi*** (Hook.f.) Press in *Bull. Br. Mus. nat. Hist. (Bot.)* **10**: 73 (1982).

Figs 13d, 38a.

*Dysophylla helferi* Hook.f., *Fl. Brit. India* **4**: 640 (1885).

*Eusteralis helferi* (Hook.f.) Panigrahi in *Phytologia* **32**: 477 (1976).

*E. helferi* (Hook.f.) Majumdar in *J. Bombay nat. Hist. Soc.* **74**: 385 (1978, '1977').

Stem solid, 4-angled, more or less glabrous, a few hairs towards the inflorescence; hairs 2-celled, *c.* 160  $\mu$ m long. Leaves in whorls of 4, linear, *c.* 30  $\times$  5 mm, base truncate, apex acute, margin dentate, lamina glabrous, punctate. Inflorescence a terminal spike, *c.* 20 mm long, with 4–5 lateral spikes; floral leaves wide, triangular-ovate to rhombic; bracts broadly or narrowly spatulate, *c.* 1 mm long. Calyx campanulate, *c.* 1.6  $\times$  2 mm, hairy outside and with white, globose glands, glabrous within; teeth ciliate and hairy at the tips, *c.* 0.5 mm long, *c.* 0.3–0.4 mm wide at base; outer hairs 2-celled, *c.* 160  $\mu$ m long. Corolla *c.* 2.5 mm long; lower lip *c.* 0.7  $\times$  0.7 mm; upper lip *c.* 1.5 mm across; central lobe *c.* 0.5  $\times$  0.5 mm; lobes with a few hairs outside. Filaments all inserted at a height of 1 mm in the tube, *c.* 2.5 mm long, exerted portion *c.* 1 mm; filaments glabrous towards the base. Style 2.8 mm long; stigma lobes *c.* 0.6–0.7 mm. Disc *c.* 0.3 mm long. Nutlets 4, *c.* 300  $\times$  250  $\mu$ m, oblong, brown, shiny, smooth.

DISTRIBUTION. India (Bengal) and Burma (Tenasserim).

SPECIMENS EXAMINED. *Helfer* 194 (BM, E), *Helfer* 3968 (K-holotype).

74. ***Pogostemon pressii*** Panigrahi in *Taxon* **33**: 1 (1989).

Figs 13e, 38b.

*Dysophylla griffithii* Hook.f., *Fl. Brit. India* **4**: 641 (1885).

*Eusteralis griffithii* (Hook.f.) Panigrahi in *Phytologia* **32**: 477 (1976).

*E. griffithii* (Hook.f.) Majumdar in *J. Bombay nat. Hist. Soc.* **74**: 386 (1978, '1977').

*Pogostemon griffithii* (Hook.f.) Press in *Bull. Br. Mus. nat. Hist. (Bot.)* **10**: 73 (1982).

Stem erect, slender, glabrous. Leaves in whorls of 4, linear, 40  $\times$  5 mm, base rounded, apex acute, margin distantly serrate, lamina glabrous, glandular. Inflorescence a single terminal spike, *c.* 60 mm long; hairs 2-celled, *c.* 250  $\mu$ m long. Calyx obconic, *c.* 1.2  $\times$  2.5 mm; outside the teeth with whitish hairs above, the tube glabrous, glabrous within; teeth ciliate, *c.* 0.4  $\times$  0.5 mm, incurved in fruit; hairs 3 celled, *c.* 370  $\mu$ m long. Corolla up to *c.* 1.7 mm long; lower lip *c.* 0.5  $\times$  0.7 mm; upper lip *c.* 1.7 mm across; central lobe *c.* 0.5  $\times$  0.4 mm. Filaments all inserted at a height of *c.* 0.7 mm in the tube, *c.* 2 mm long, exerted portion *c.* 1 mm; filaments glabrous at the base. Style *c.* 2.2 mm long; stigma lobes *c.* 0.3 mm. Disc *c.* 0.2 mm long. Nutlets 4, *c.* 500  $\times$  400  $\mu$ m, oblong with attachment point at base, dark brown, smooth.

DISTRIBUTION. India (Madras) and China.

SPECIMENS EXAMINED. *Chattaya* 5224 (K), *Gamble* 13748 (K), *Griffiths* 3968 (K-holotype).

75. ***Pogostemon stocksii*** (Hook.f.) Press in *Bull. Br. Mus. nat. Hist. (Bot.)* **10**: 74 (1982).

Figs 13f, 38c.

*Dysophylla stocksii* Hook.f., *Fl. Brit. India* **4**: 642 (1885).

*Eusteralis stocksii* (Hook.f.) Panigrahi in *Phytologia* **32**: 478 (1976).

*E. stocksii* (Hook.f.) Majumdar in *J. Bombay nat. Hist. Soc.* **74**: 386 (1978, '1977').

Stem solid, terete, glabrous. Leaves in whorls of 10 or more, linear, *c.* 16  $\times$  2 mm, base truncate, apex acuminate, margin entire, lamina glabrous. Inflorescence a single terminal spike, *c.* 45 mm long; bracts cup-shaped, with fine hairs at the tip and margin. Calyx campanulate, pentagonous, *c.* 1  $\times$  2 mm; sparsely hairy outside, glabrous within, the teeth glandular; teeth ciliate, *c.* 0.4  $\times$  0.4 mm, incurved in fruit; outer hairs 2-celled, *c.* 200  $\mu$ m long. Corolla *c.* 1.4 mm long; lower lip 0.5  $\times$  0.5 mm; upper lip 1.4 mm across; central lobe 0.5  $\times$  0.5 mm, with a few hairs and many glands. Filaments all inserted at a height of 0.5 mm in the tube, *c.* 2.5–2.8 mm long, exerted portion *c.* 1.9 mm; filaments glabrous towards the base. Style *c.* 2.4 mm long; stigma lobes *c.* 0.4 mm. Disc *c.* 0.2 mm. Nutlet 1, *c.* 600  $\times$  200  $\mu$ m, narrowly oblong, light brown, smooth.

DISTRIBUTION. Southwestern India (Bombay, Concan).

SPECIMENS EXAMINED. *Stocks* s.n. in Herb. Hooker (K-holotype).

76. ***Pogostemon erectus*** (Dalzell) Kuntze, *Rev. gen. pl.* **2**: 530 (1891).

Figs 13g, 39a.

*Dysophylla gracilis* Dalzell in *Hooker's J. Bot.* **2**: 337 (1850), non *Pogostemon gracilis* Hassk. (1843).

*Eusteralis gracilis* (Dalzell) Panigrahi in *Phytologia* **32**: 476 (1976).

*E. erecta* (Kuntze) Panigrahi in *Phytologia* **32**: 477 (1976).

*E. erecta* (Kuntze) Majumdar in *J. Bombay nat. Hist. Soc.* **74**: 386 (1978, '1977').

*E. gracilis* (Dalzell) Majumdar in *J. Bombay nat. Hist. Soc.* **74**: 386 (1978, '1977').

*E. tomentosa* var. *gracilis* Bennet & Raizada in *Indian Forester* **108**: 303 (1982).

Stem erect, terete, brown to purplish, sparsely hairy; hairs 3-celled, *c.* 375  $\mu$ m long. Leaves in whorls of 10 or more, linear, *c.* 2.5  $\times$  1 mm, base truncate, apex acute, margin entire, revolute; hairs few, up to 3-celled, *c.* 250  $\mu$ m long. Inflorescence a single terminal spike, *c.* 70 mm long; hairs 3-celled, *c.* 370  $\mu$ m long; floral leaves claviform, two hairs at apex giving appearance of a cobra head with exerted tongue; bracts filiform-spatulate, *c.* 1–2 mm long. Calyx campanulate, *c.* 1.7  $\times$  2.1 mm; very hairy outside, especially in upper half, teeth hairy within; teeth ciliate, *c.* 0.5–0.6 mm long; outer hairs white, up to 3-celled, *c.* 430  $\mu$ m long. Corolla up to 2.4 mm long; lower lip *c.* 0.6  $\times$  0.6 mm; upper lip *c.* 1.4 mm across; central lobe *c.* 0.5  $\times$  0.4 mm; lobes hairy. Filaments all inserted at a height of *c.* 1 mm in the tube, *c.* 2.5–2.7 mm long, exerted portion *c.* 1 mm; filaments hairy from middle to connective of anthers, all equally hairy at the base. Style *c.* 3.5 mm long; stigma lobes *c.* 0.7 mm. Disc *c.* 3 mm long, unequal with one arm elongated. Nutlets 4, *c.* 400  $\times$  200  $\mu$ m, oblong, tan, smooth.

DISTRIBUTION. India (Bombay).

SPECIMENS EXAMINED. *Dalzell* s.n. (K-holotype), *Hooker* s.n. (K).

var. ***diplobatus*** Bhatti & Ingr., var. nov.

a var. *erecto, toro bilobo dignoscenda*.

TYPE. India: Kerala; Karimbam, 23 December 1980, *Ansari* 69986 (K!-holotype).

Differs from var. *erectus* in having a 2 armed disc.

77. ***Pogostemon stellatus*** (Lour.) Kuntze, *Rev. gen. pl.* **2**: 429 (1891).

Figs 13h, 39b.

*Mentha stellata* Lour. in *Flora cochinch.* 2: 361 (1790).  
*Dysophylla stellata* (Lour.) Benth. in Wall., *Pl. asiat. rar.* 1: 30 (1830), non *Mentha stellata* Roxb. (1814).  
*D. benthamiana* Hance in *Ann. Sc. Nat.* V, 5: 234 (1866), pro parte.  
*D. peguana* auct., non Prain (1891).  
*Eusteralis stellata* (Lour.) Panigrahi in *Phytologia* 32: 477 (1976).  
*E. malabarica* (Lour.) Majumdar in *J. Bombay nat. Hist. Soc.* 74: 385 (1978, '1977'), nom. inval.

Stem solid, terete, with short internodes, puberulent; hairs 3-celled, c. 310 µm long. Leaves in whorls of up to 10, linear, 9 × 2 mm, base truncate, apex acuminate, margin entire, revolute; hairs 2-celled, c. 125 µm long. Inflorescence a single terminal spike, c. 55 mm long; bracts linear-clavate or spatulate, c. 1 mm long. Calyx campanulate, c. 1.5 × 2.2 mm, tube and teeth hairy within and with white hairs outside; teeth ciliate, c. 0.4–0.5 mm long, 0.4–0.5 mm wide at base, incurved in fruit; outer hairs 2-celled, c. 190 µm long. Corolla c. 1.7 mm long; lower lip c. 0.6 × 0.6 mm; upper lip 1.5 mm across; central lobe c. 0.5 × 0.5 mm; upper and lower lip hairy outside. Filaments all inserted at a height of 0.8 mm in the tube, two under central lobe (inner) c. 3.3 mm long, two on lower side c. 3 mm long, exerted portion c. 2.4 mm; filaments puberulent at the base and with moniliform hairs from middle to connective of anthers. Style c. 3.4 mm long; stigma lobes c. 0.9 mm. Disc c. 0.2 mm long, unequal. Nutlets 4, c. 600 × 350 µm, oblong, tan, smooth.

DISTRIBUTION. India (Bombay, Calicut, Karnataka, Mysore, Madras), Bangladesh, and Hong Kong. In rice paddies.

SPECIMENS EXAMINED. *Dalz* s.n. (K), *Gibbs* 7725 (K), *Heynes* 1542 (K), *Loureiro* s.n. (BM-holotype), *Rao* 26 (K), *Wight* 2131 (K), *Wight* 2136 (K).

Tahir *et al.* (1995) report orbicular nutlets with protruberances in material from Bangladesh.

78. *Pogostemon deccanensis* (Panigrahi) Press in *Bull. Br. Mus. nat. Hist. (Bot.)* 10: 73 (1982).  
 Figs 13i, 39c.

*Dysophylla tomentosa* Dalzell in *Hooker's J. Bot.* 2: 337 (1850), non *Pogostemon tomentosa* Hassk. (1844).

*Eusteralis deccanensis* Panigrahi in *Phytologia* 32: 475 (1976).  
*E. tomentosa* (Dalzell) Panigrahi in *Phytologia* 32: 477 (1976).  
*E. tomentosa* (Dalzell) Majumdar in *J. Bombay nat. Hist. Soc.* 74: 385 (1978, '1977').

Stem terete, with short internodes, brownish violet; hairs 3-celled, c. 250 µm long. Leaves in whorls of 6–8 or more, linear, c. 8 × 2 mm, base truncate, apex acute, margin more or less entire, revolute; hairs 3-celled, c. 437 µm long. Inflorescence a single terminal spike, c. 50 mm long, tapering towards apex; hairs 5-celled, c. 1000 µm long; bracts filiform-spatulate, c. 1–2 mm long. Calyx campanulate, c. 1.7 × 3 mm; teeth and tube hairy within, hairy and glandular outside; teeth ciliate, the longest c. 0.6–0.7 mm long, 0.4–0.6 mm wide at base; outer hairs 4-celled, c. 500 µm long. Corolla c. 2.3 mm long; lower lip 0.9 × 0.9 mm; upper lip c. 1.7 mm across; central lobe c. 0.5 × 0.5 mm; upper and lower lip hairy outside. Filaments all inserted at a height of c. 1 mm in tube, c. 3.2–3.5 mm long, exerted portion c. 2.2 mm; two filaments with long moniliform hairs from the middle to connective of anthers, two filaments only hairy at middle, all glabrous at the base. Style c. 3.8 mm long; stigma lobes c. 0.5 mm. Disc c. 0.2 mm long, uneven, with one lobe elongated c. 0.3 mm in notch between nutlets. Nutlets 4, c. 500 × 450 µm, orbicular, tan with whitish notch at the base, smooth to reticulate.

DISTRIBUTION. India (Bombay, Mysore, Madras).

SPECIMENS EXAMINED. *Dalz* s.n. (K-holotype), *Madras Herb.* 11982 (K), *Ramamoorthy* 1407 (K).

79. *Pogostemon aquaticus* (C.H. Wright) Press in *Bull. Br. Mus. nat. Hist. (Bot.)* 10: 73 (1982).  
 Figs 13j, 40.

*Elsholtzia aquatica* C.H. Wright in Dyer, *Fl. Trop. Afr.* 5: 451 (1900).

Stem terete, hollow, glabrous except at the nodes; hairs 4-celled; c. 430 µm long. Leaves in whorls of 4, linear, c. 18 × 6 mm, base cuneate, apex acute, margin entire, glandular, lamina more or less glabrous, a few hairs on the midrib on abaxial surface. Inflorescence a terminal spike with six lateral spikes, all in a single whorl; terminal spike with long peduncle c. 70 mm long and a dense spike of more or less the same length, first whorl separated, lateral spikes c. 30 mm long, equalling peduncles. Floral leaves linear, c. 2 mm long. Calyx campanulate, c. 2 × 3 mm; glabrous but glandular within, hairy outside, more densely above to sparsely at the base; teeth ciliate, c. 0.7 mm long, 0.5–0.7 mm wide at base; outer hairs 2-celled, c. 310 µm long. Corolla c. 3 mm long; lower lip 1.2 × 1.2 mm, strigose within; upper lip c. 2 mm across; central lobe c. 1 × 0.7 mm; lobes ciliate at margin. Filaments all attached at a height of 1.2 mm in the tube, c. 2.5–3.2 mm long, exerted portion c. 2.2 mm; filaments glabrous at the base. Style c. 4 mm long; stigma lobes c. 0.7 mm. Disc 0.4 mm long. Nutlets 4, c. 900 × 600 µm, oblong, dark brown to black, smooth.

DISTRIBUTION. East Africa, Zimbabwe, Mozambique (Unangu to Lake Shireva), and Malawi (Dedza, Chongoni forest).

SPECIMENS EXAMINED. *Fanshawe* F8512 (K), *Johnson* 15 (K-type), *Salubeni* 1780 (K), *Salubeni* 1888 (K), *Wight* 8530 (K).

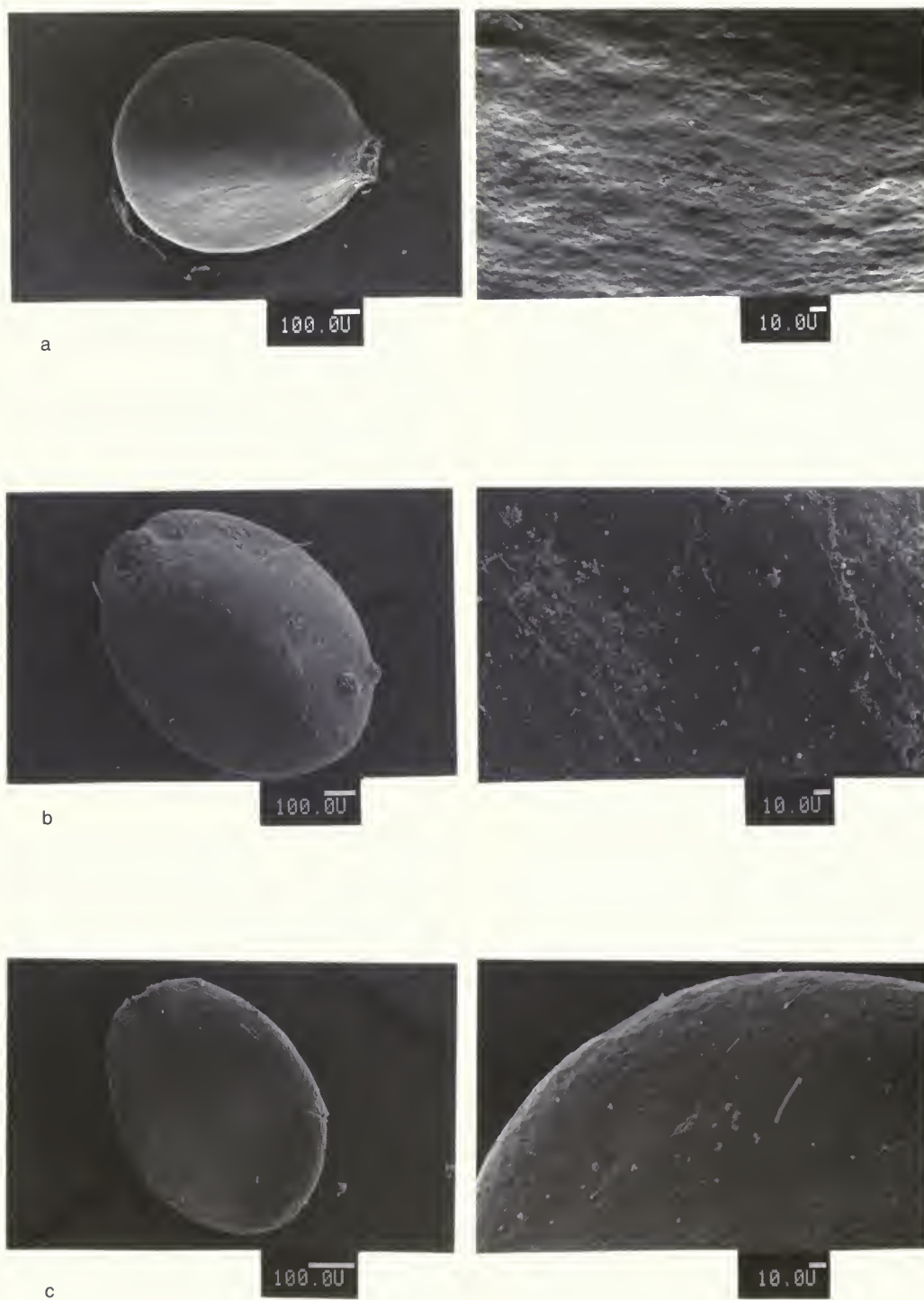
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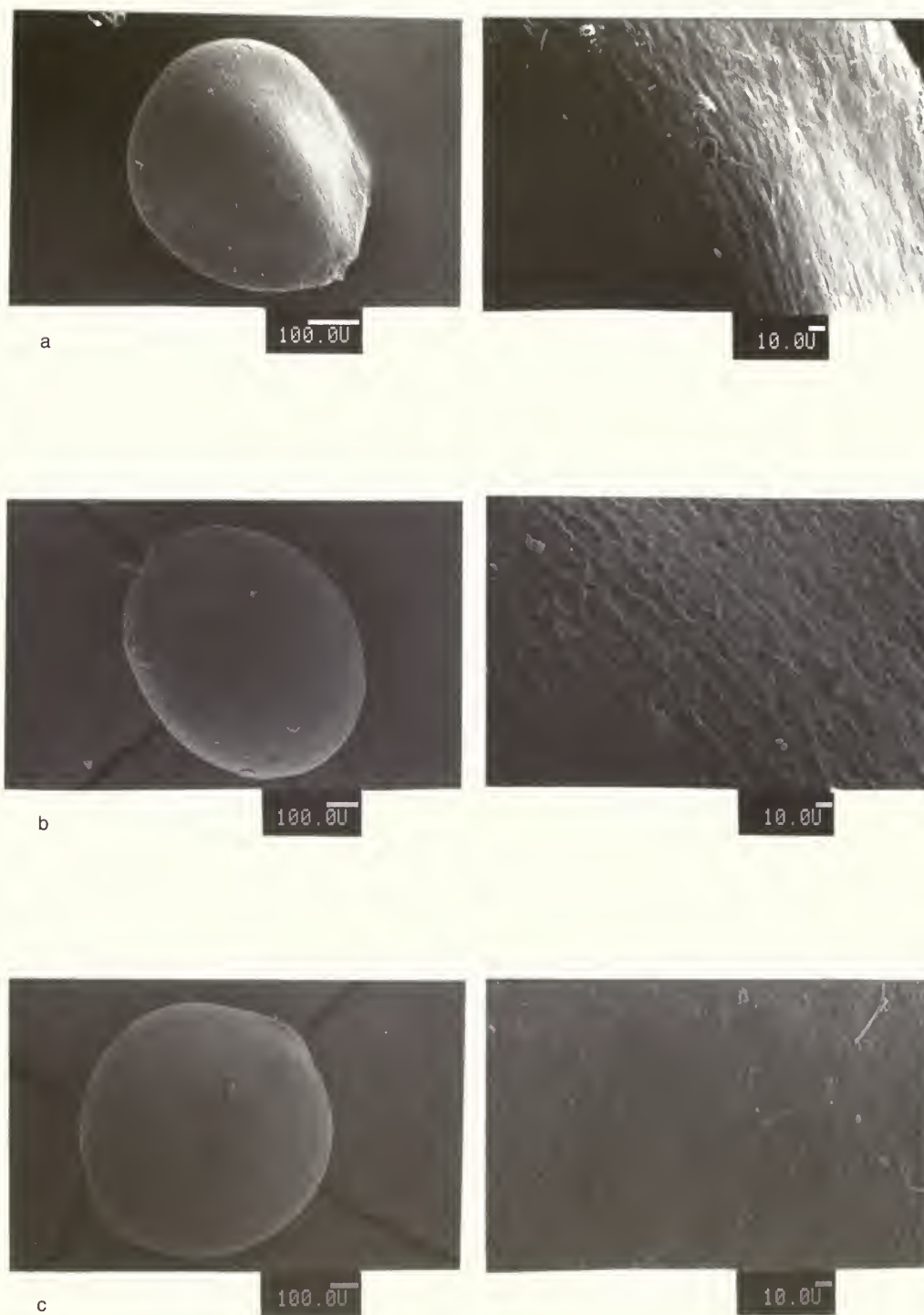


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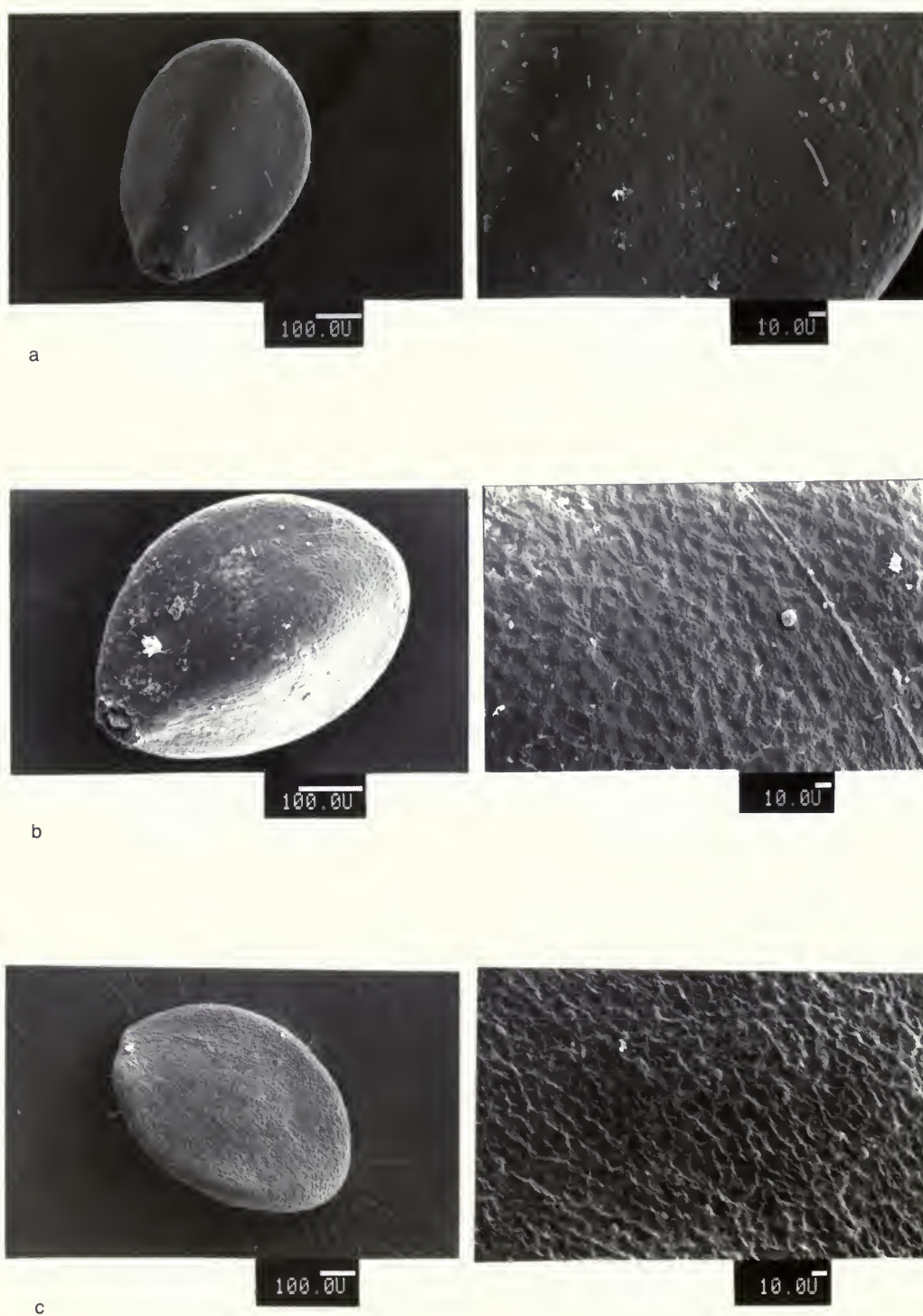


**Fig. 14** Nutlet and nutlet surface. (a) *P. benghalensis*, (b) *P. villosus*, (c) *P. plectranthoides*.



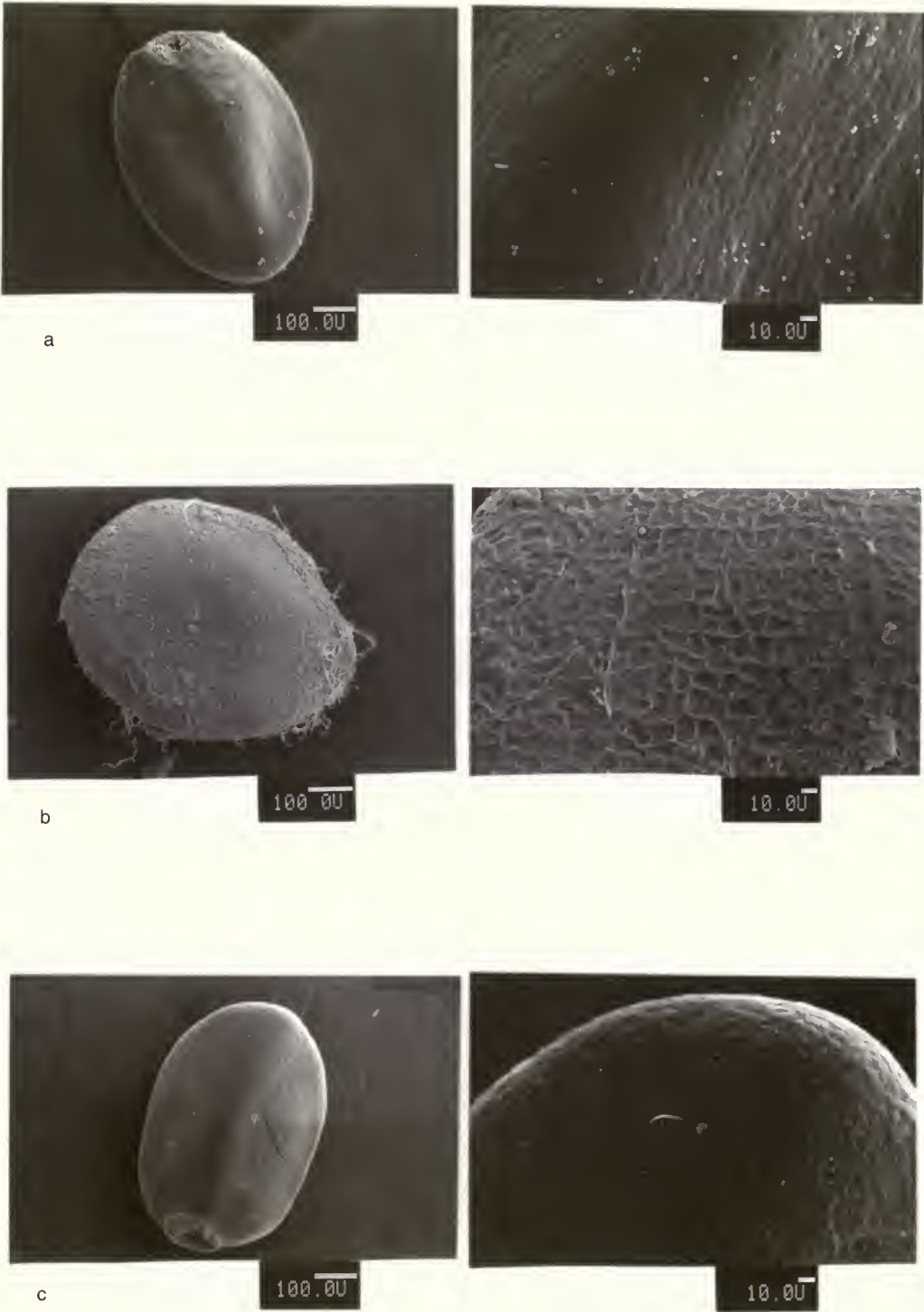


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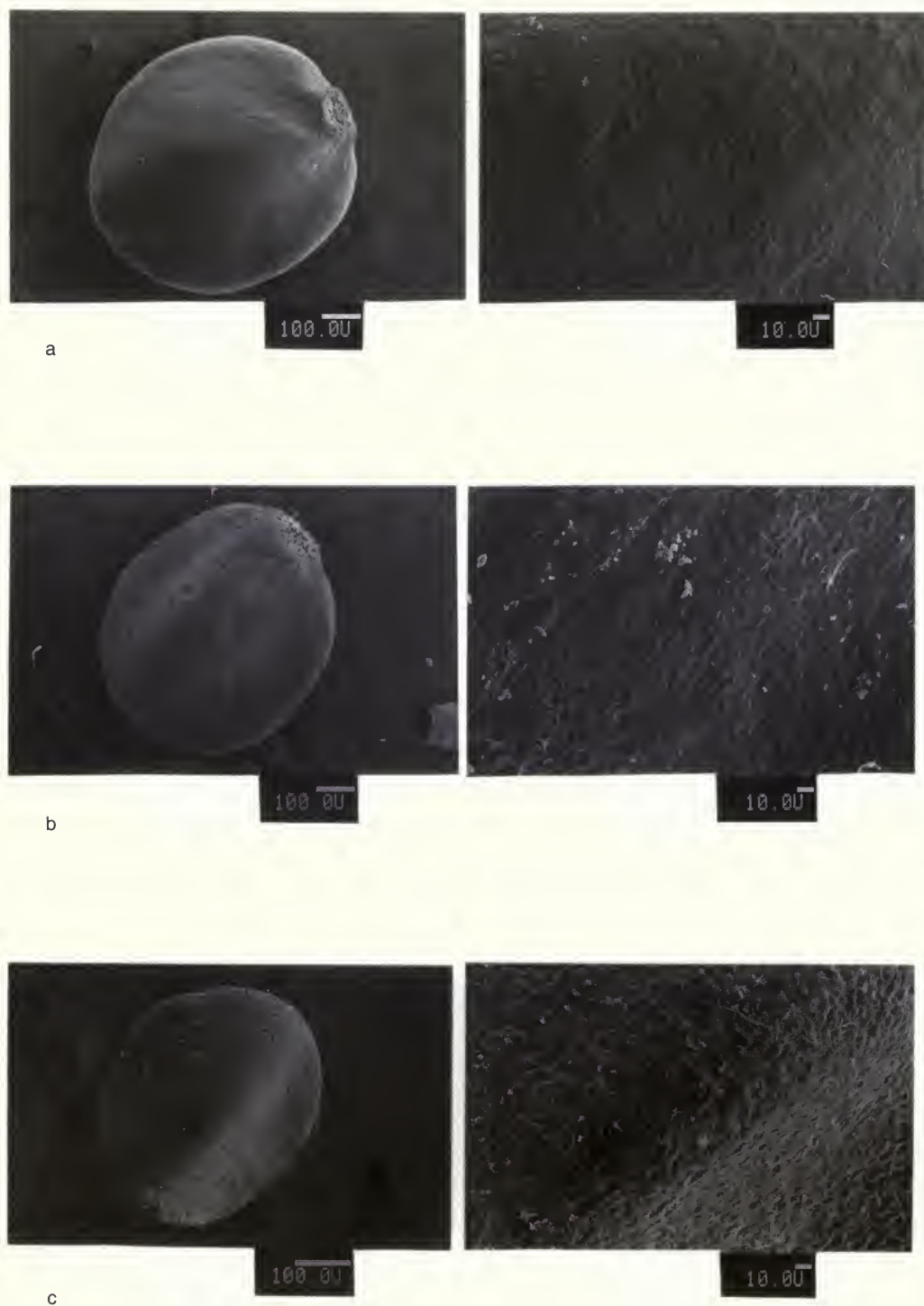
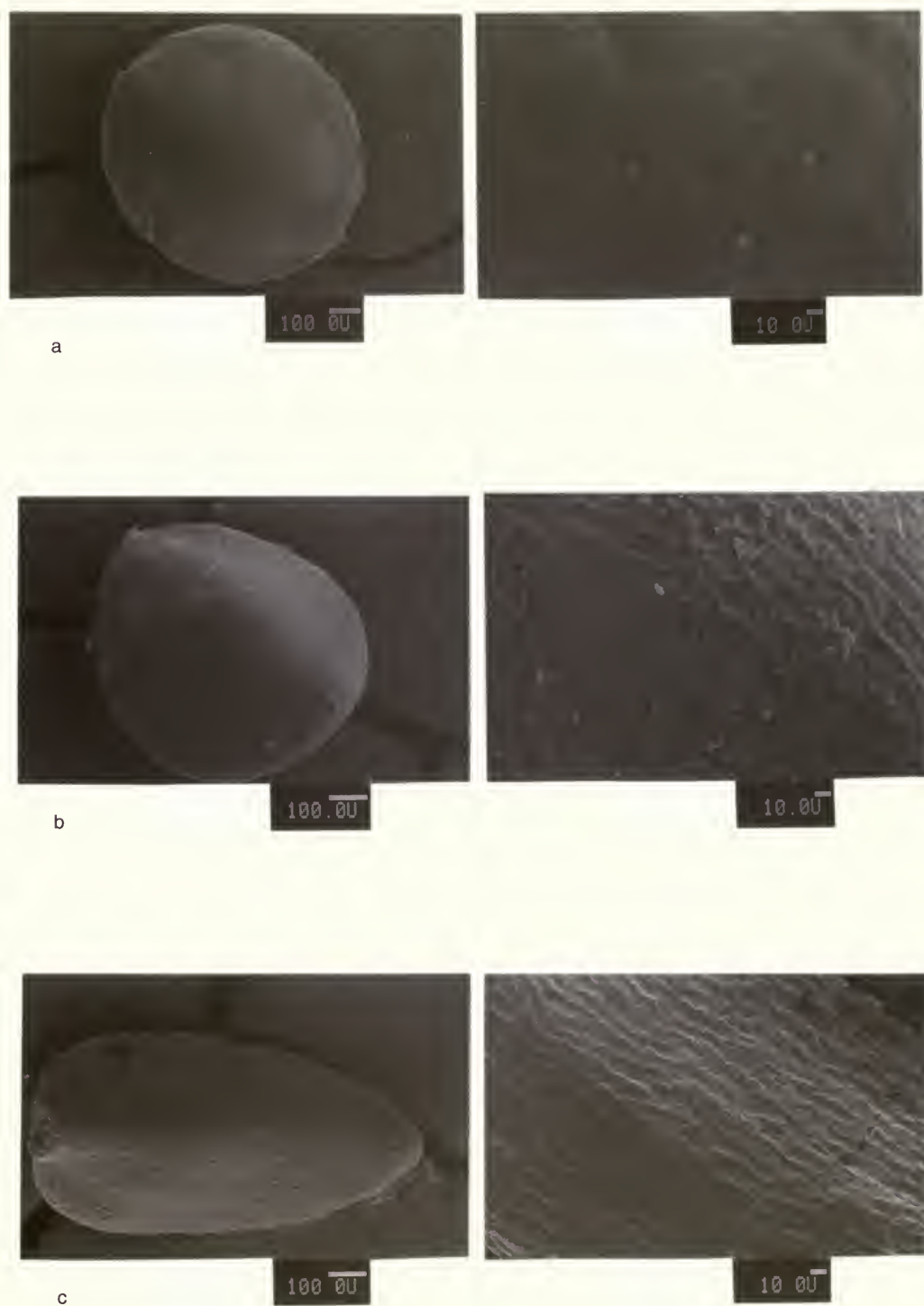
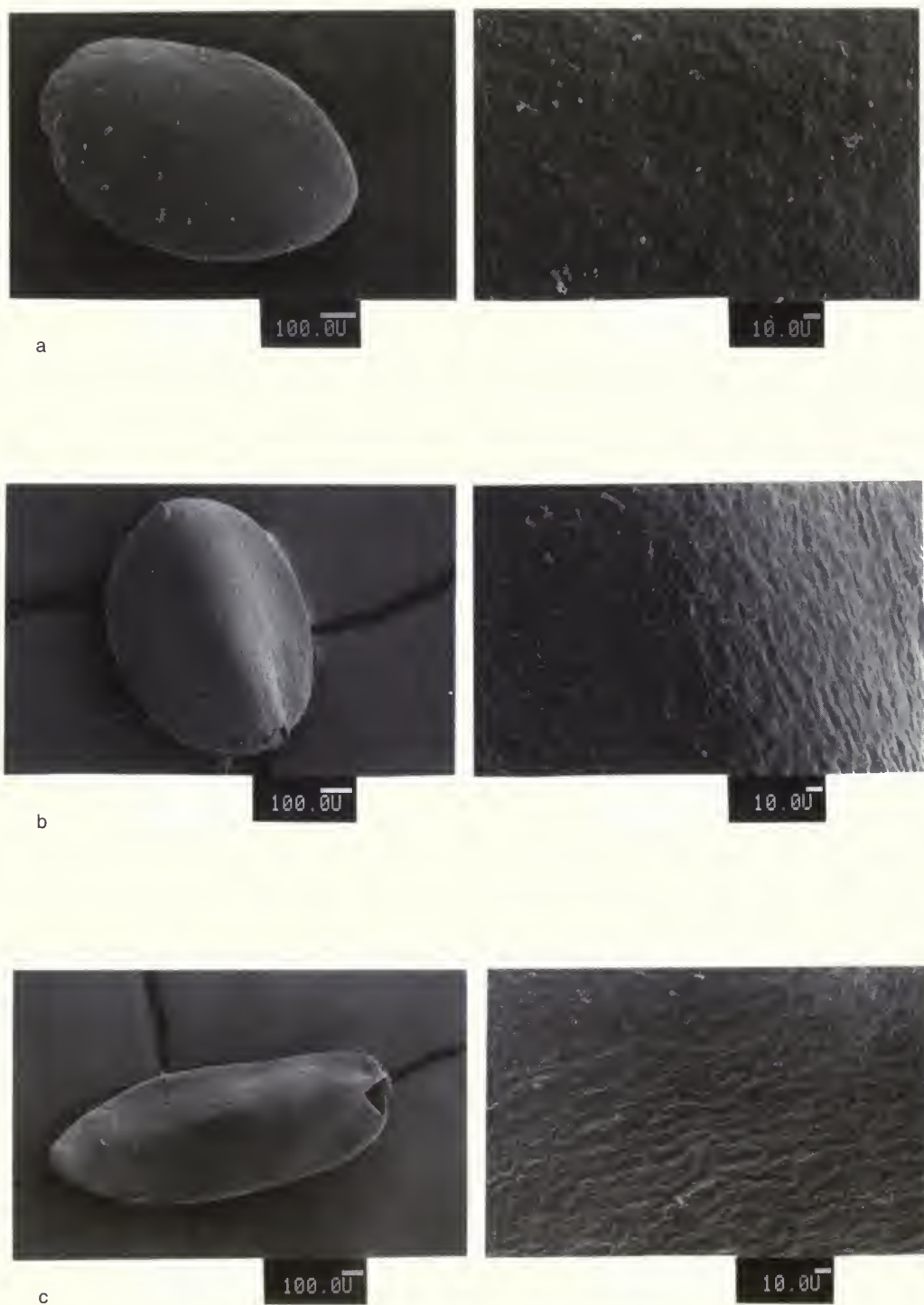


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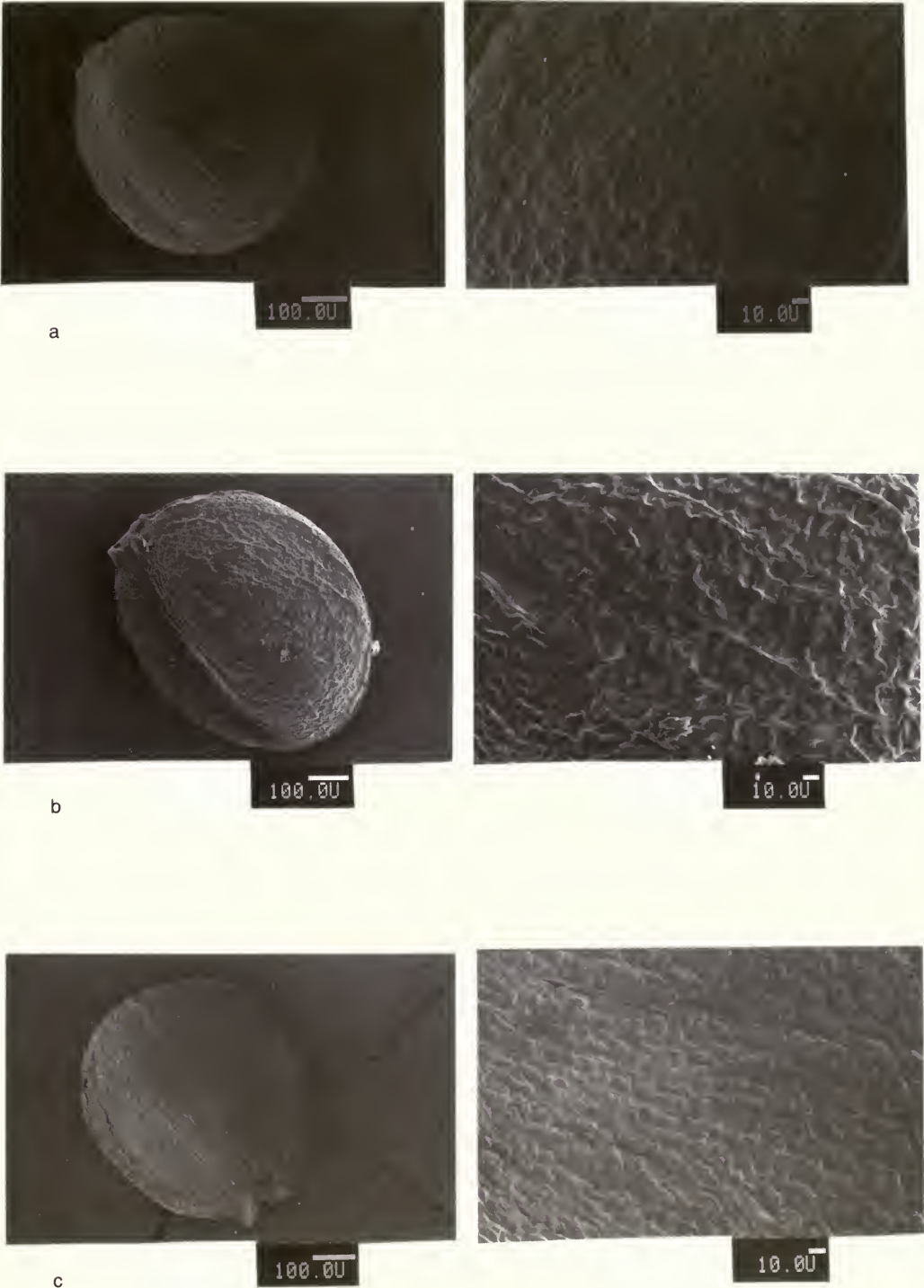


**Fig. 19** Nutlet and nutlet surface. (a) *P. championii*, (b) *P. formosanus*, (c) *P. elsholtzioides*.

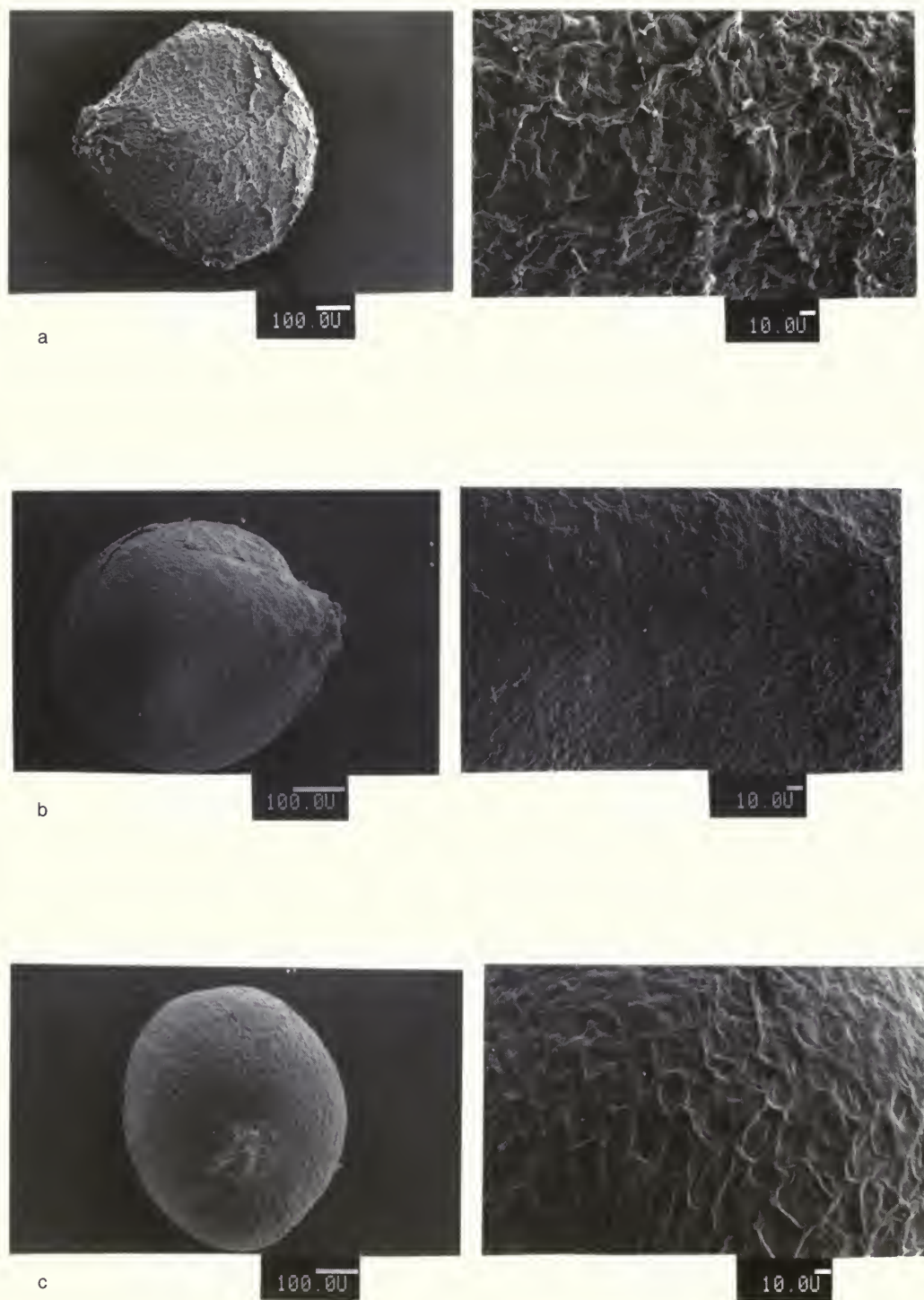


**Fig. 20** Nutlet and nutlet surface. (a) *P. tuberosus*, (b) *P. griffithii*, (c) *P. dielsianus*.



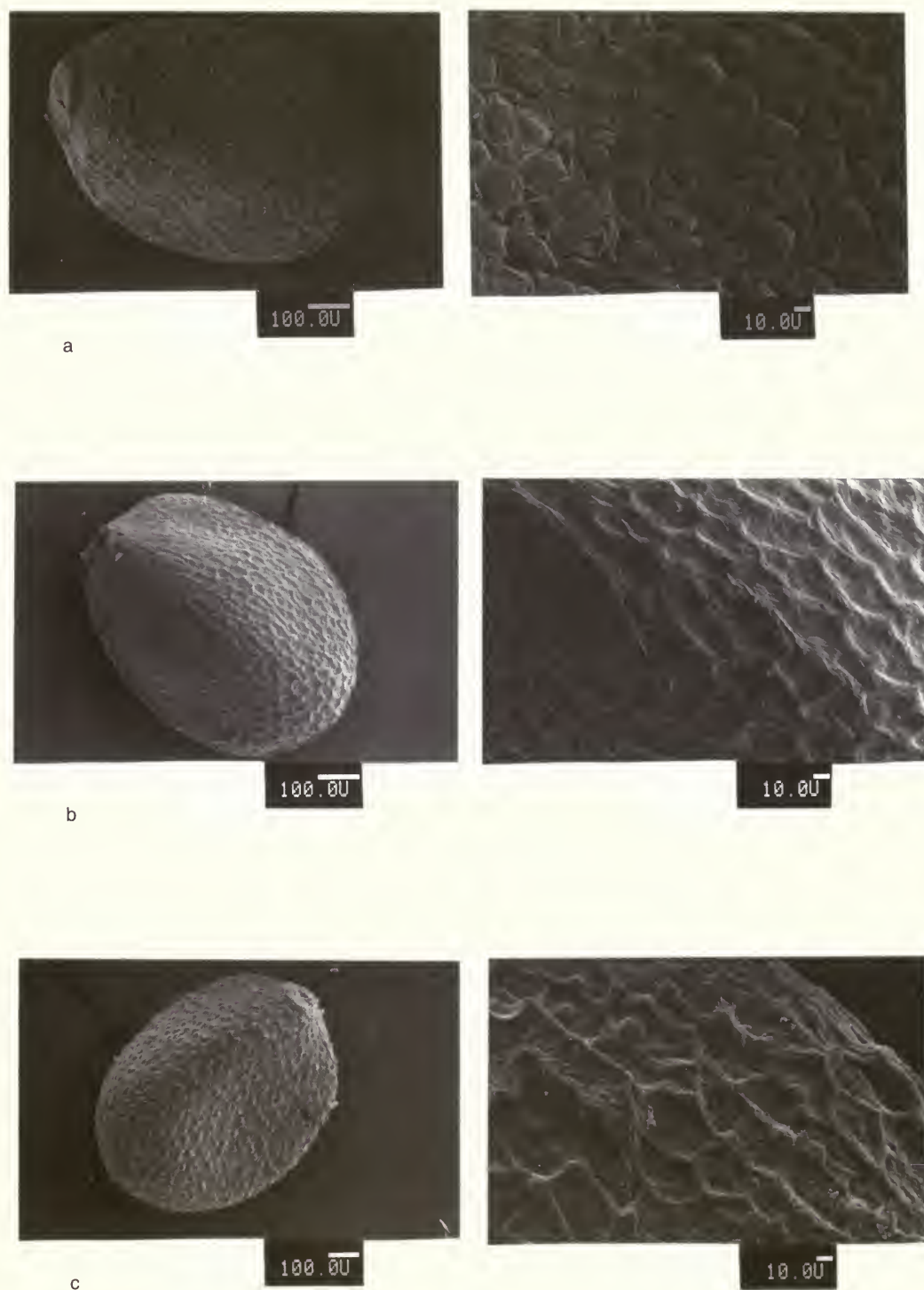


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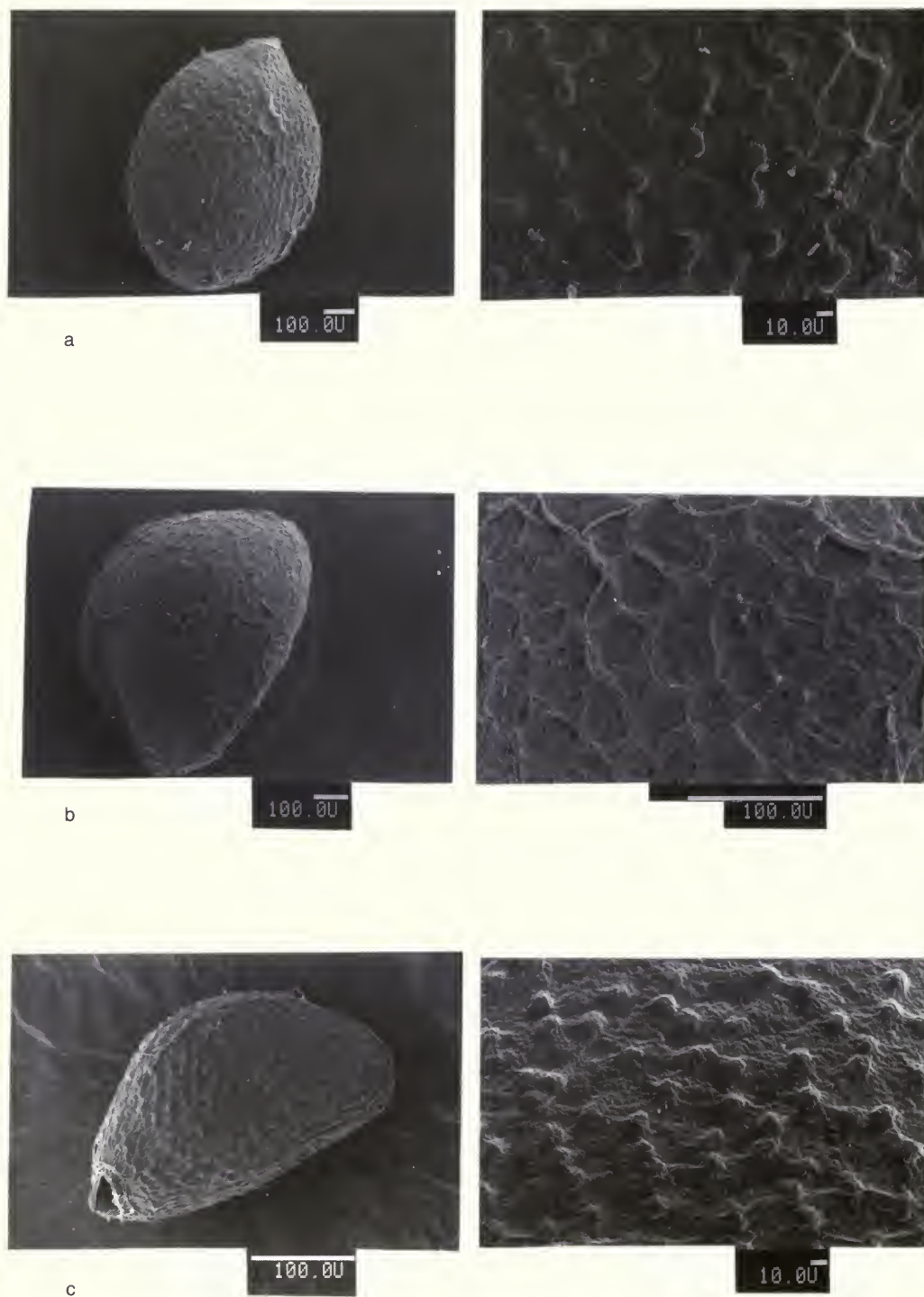


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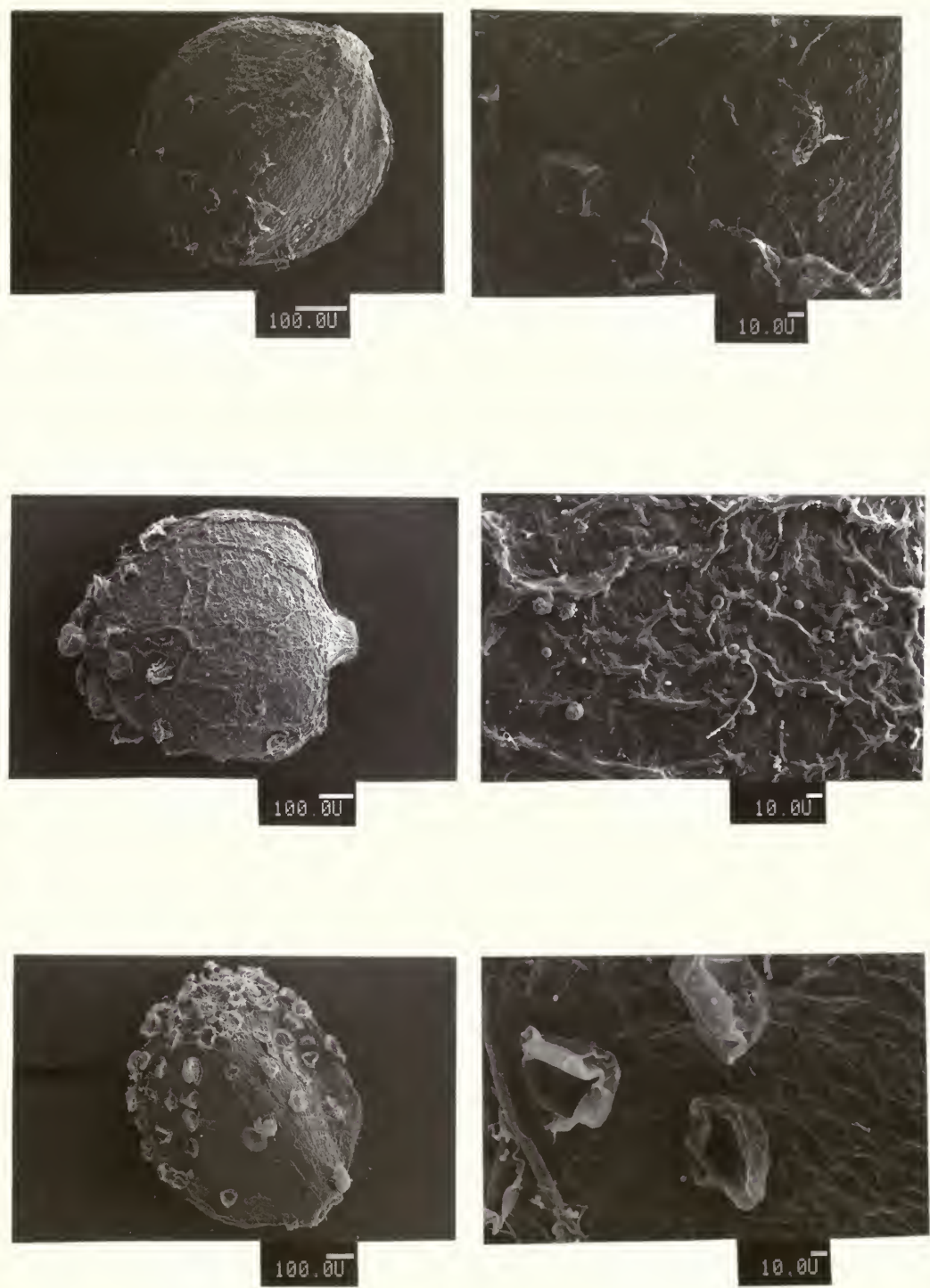


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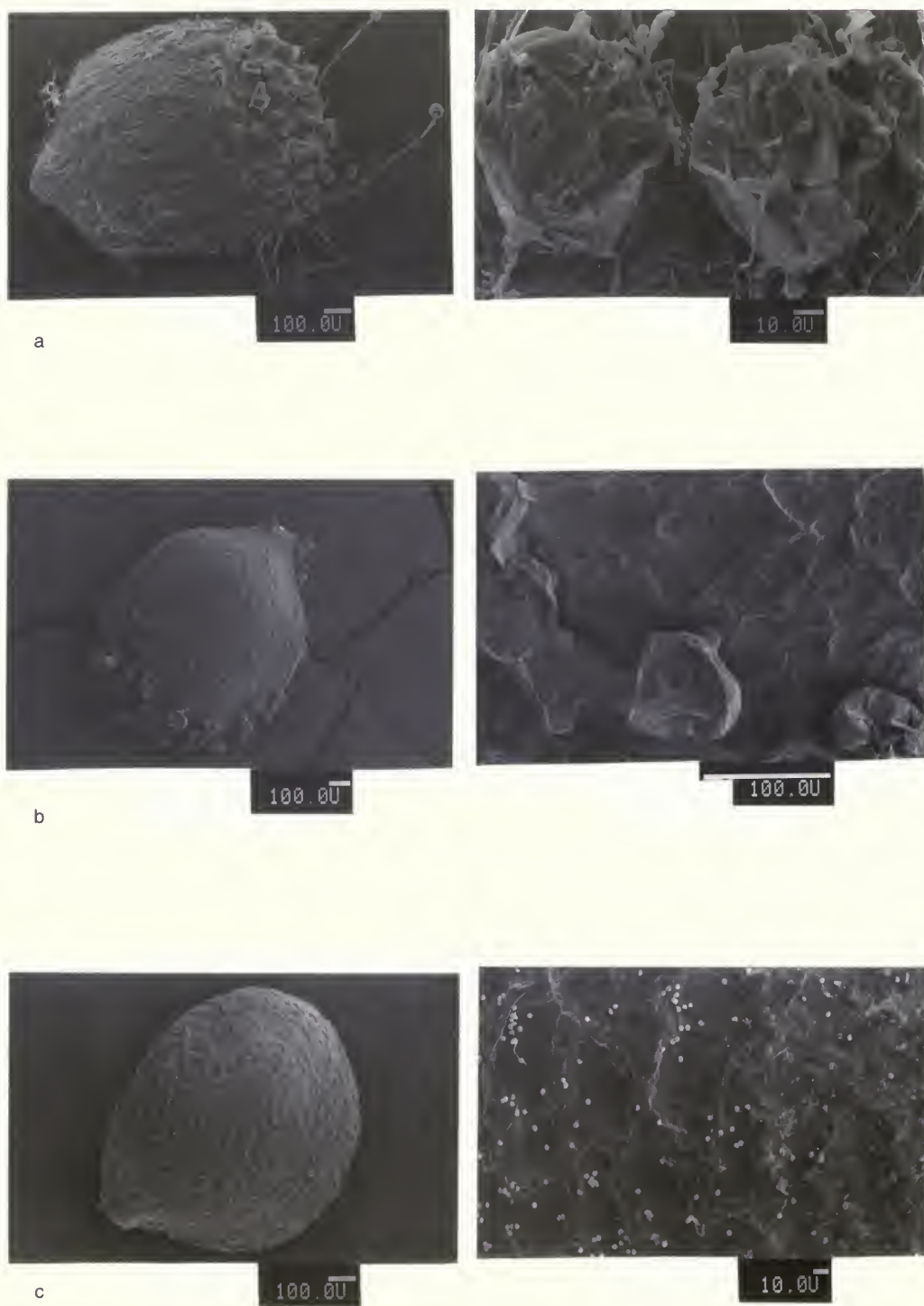
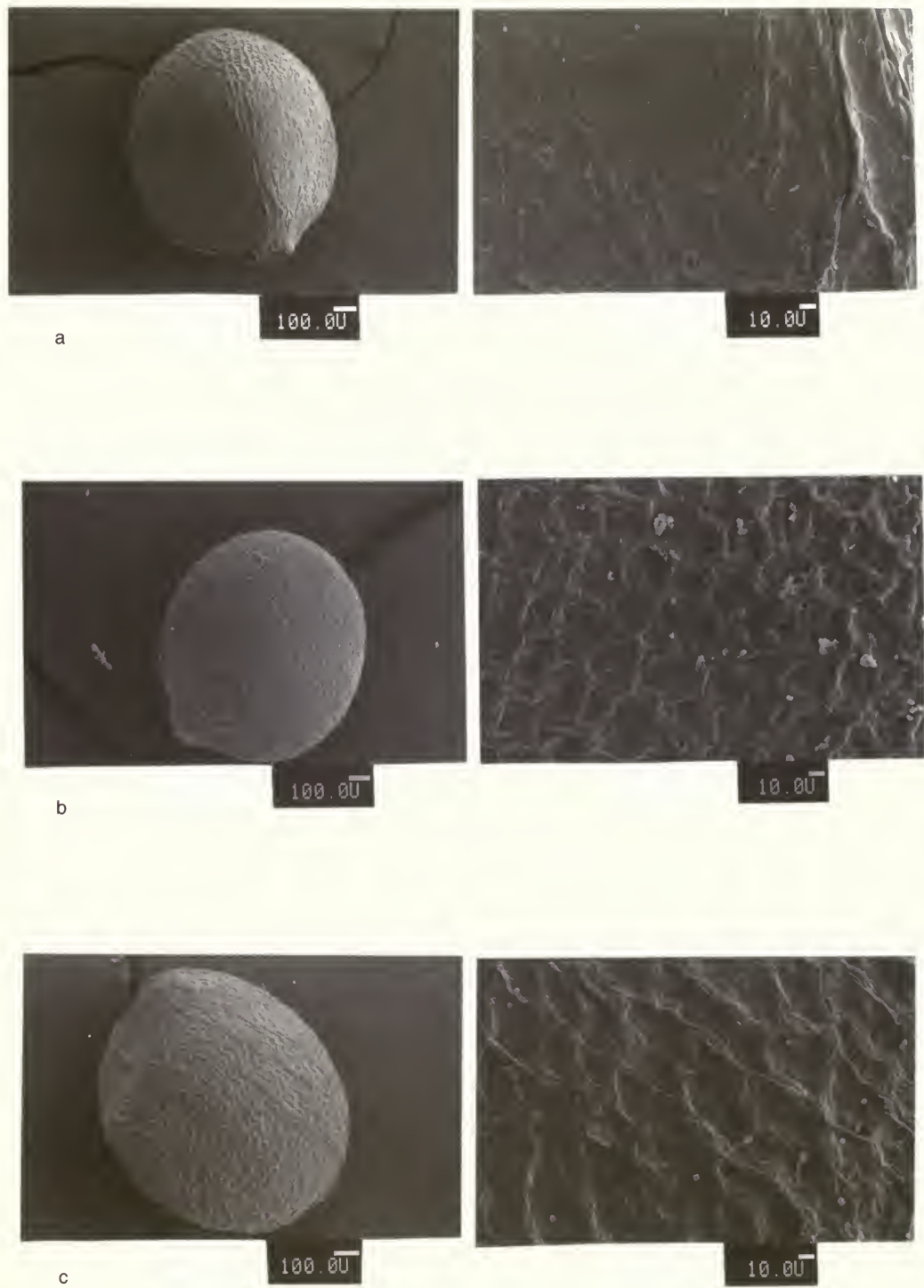
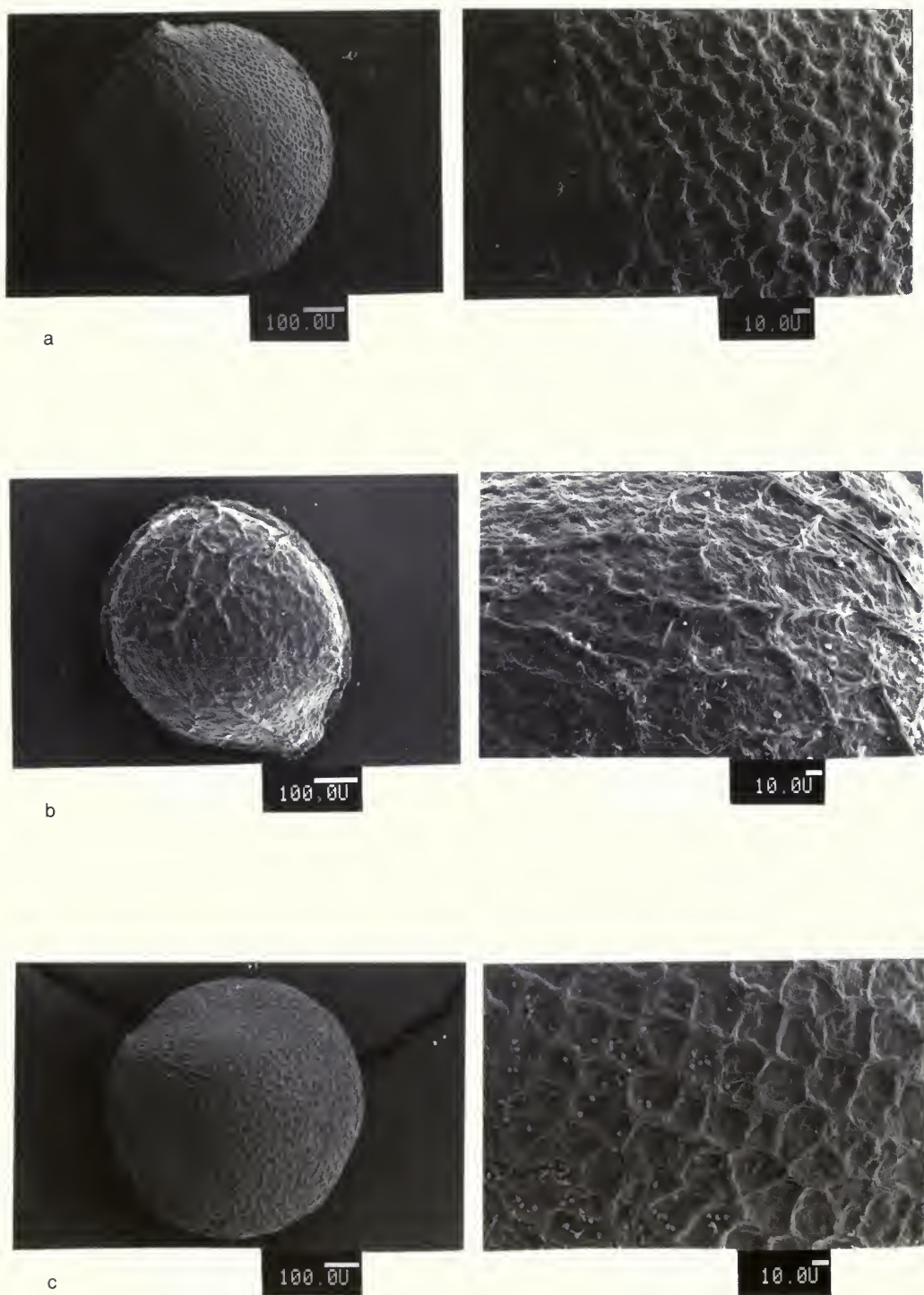


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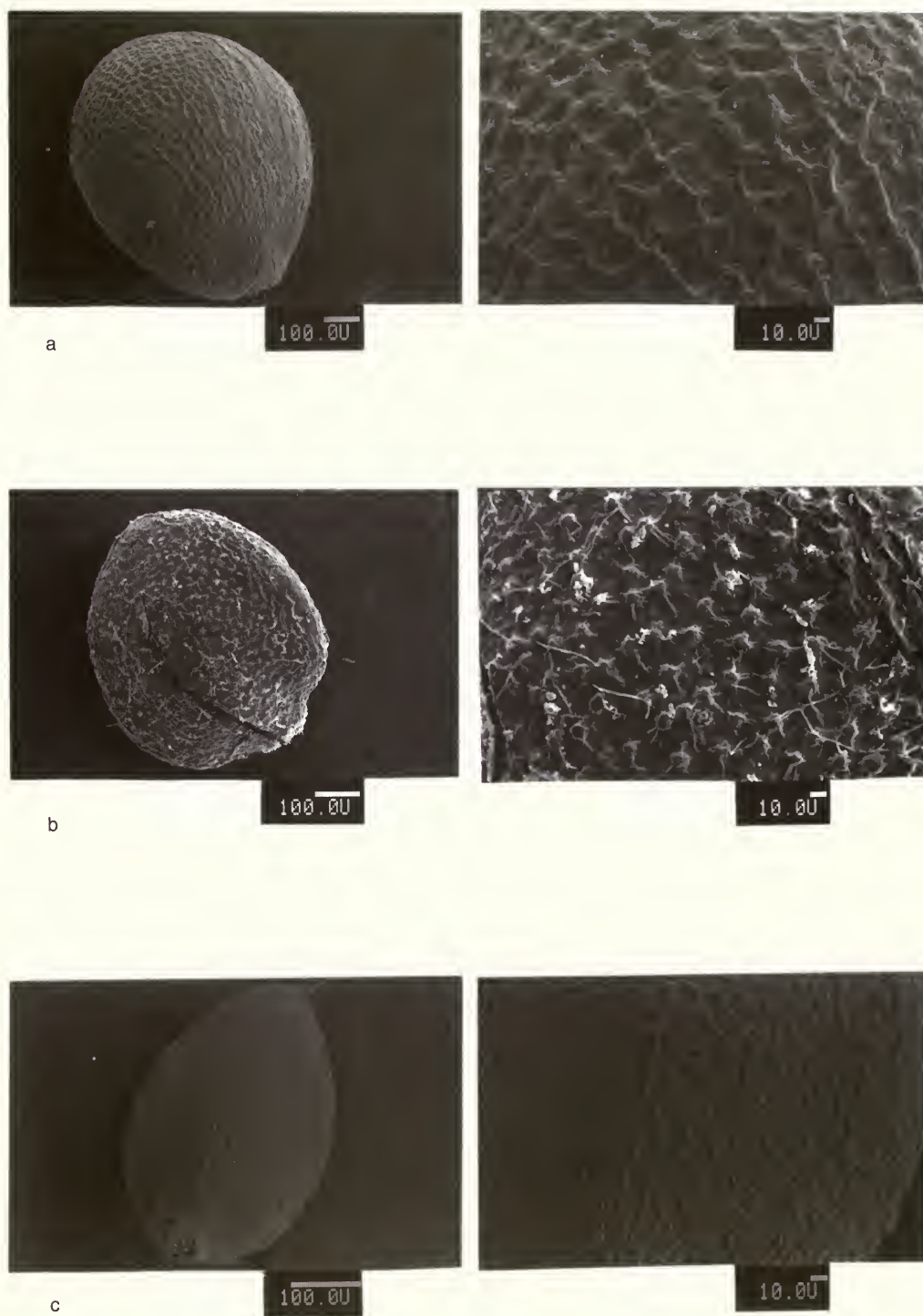
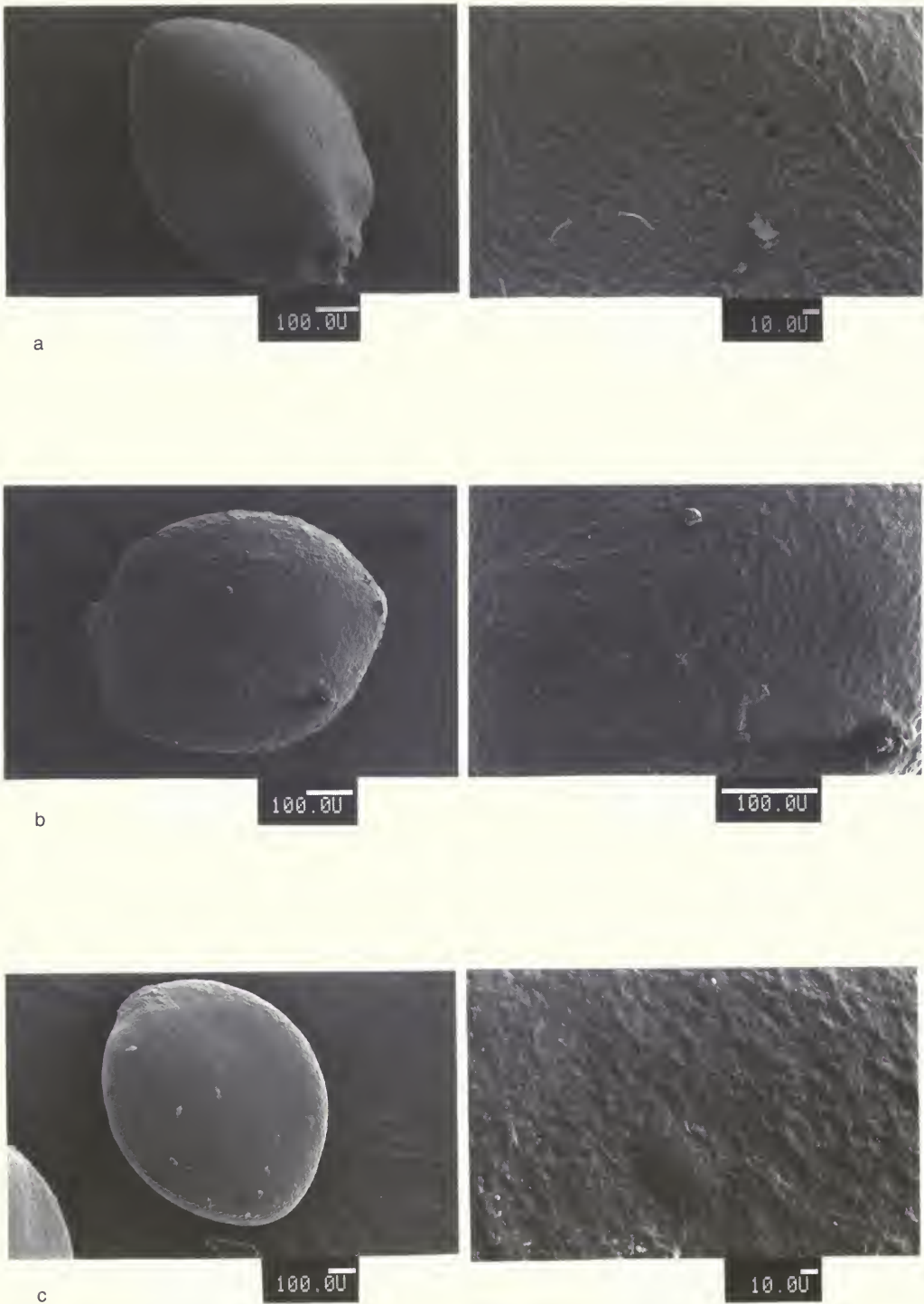
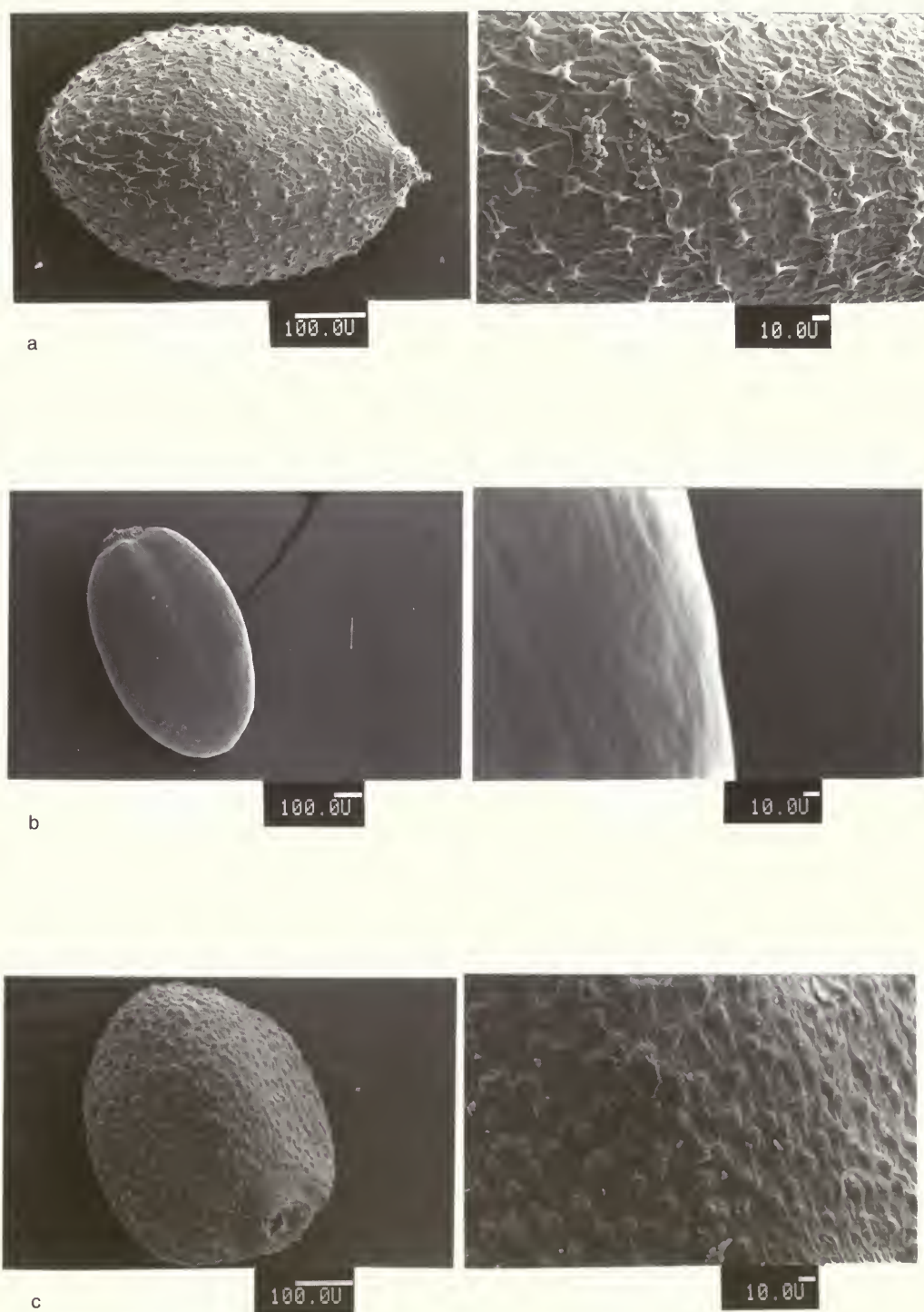


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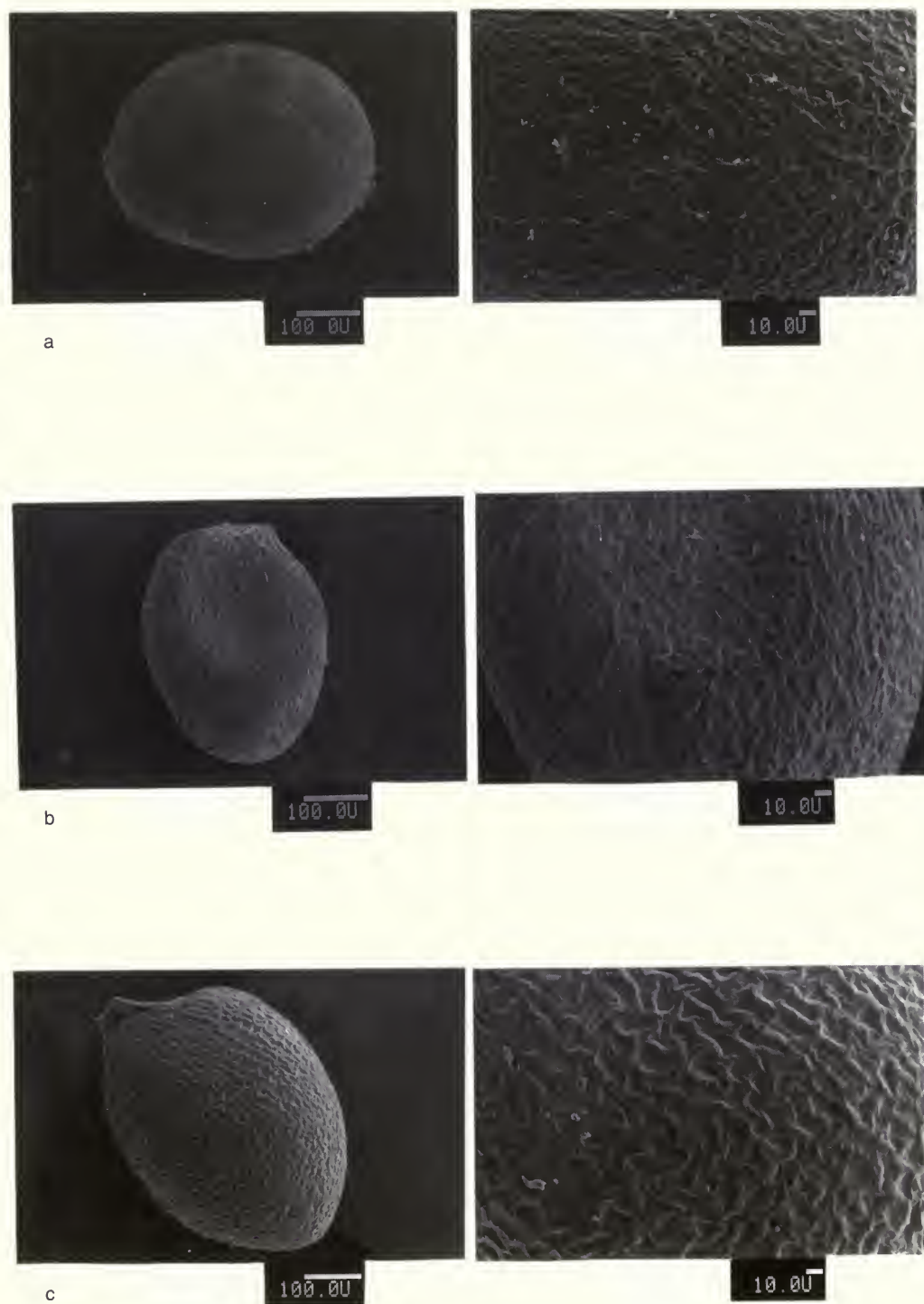


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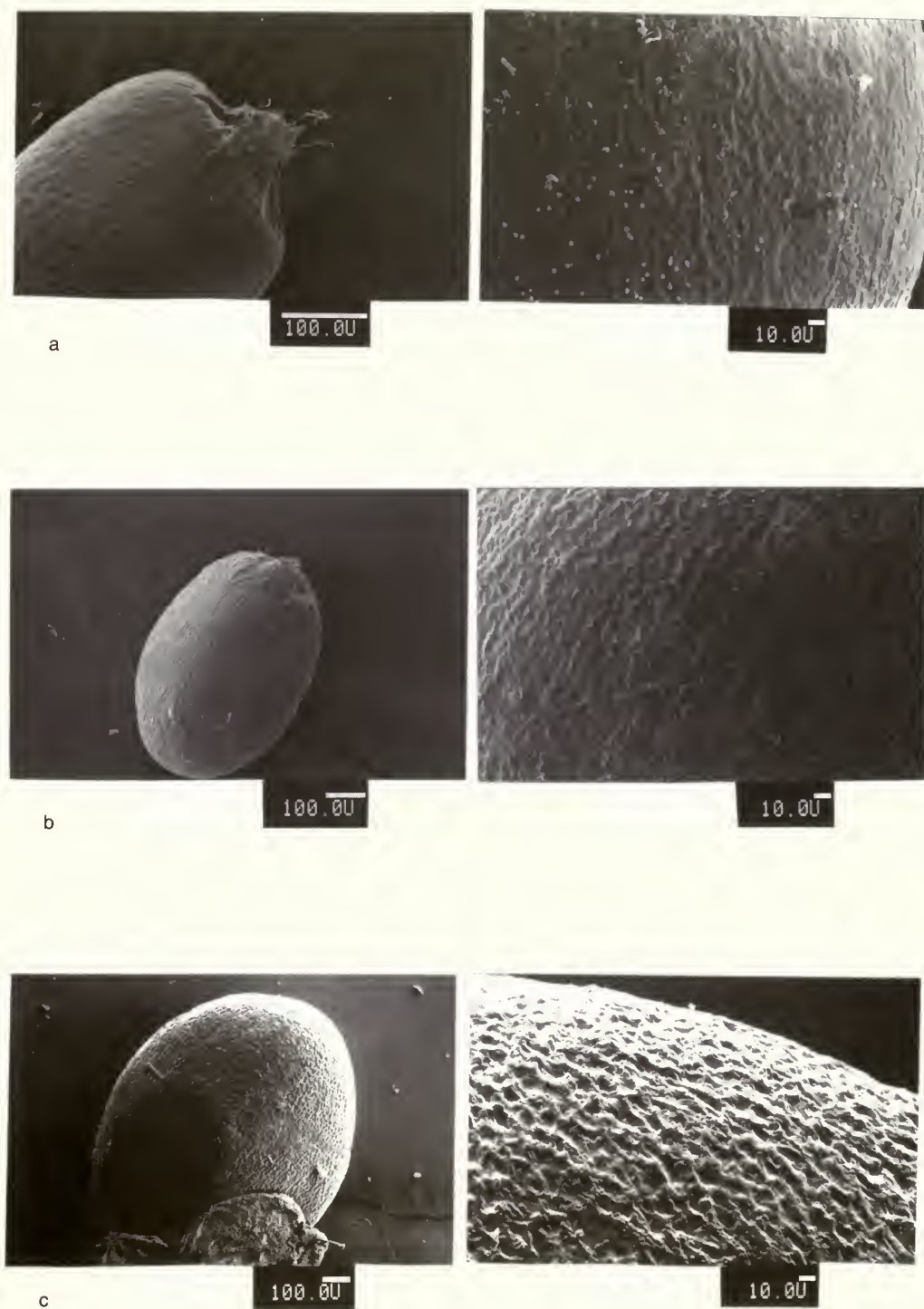




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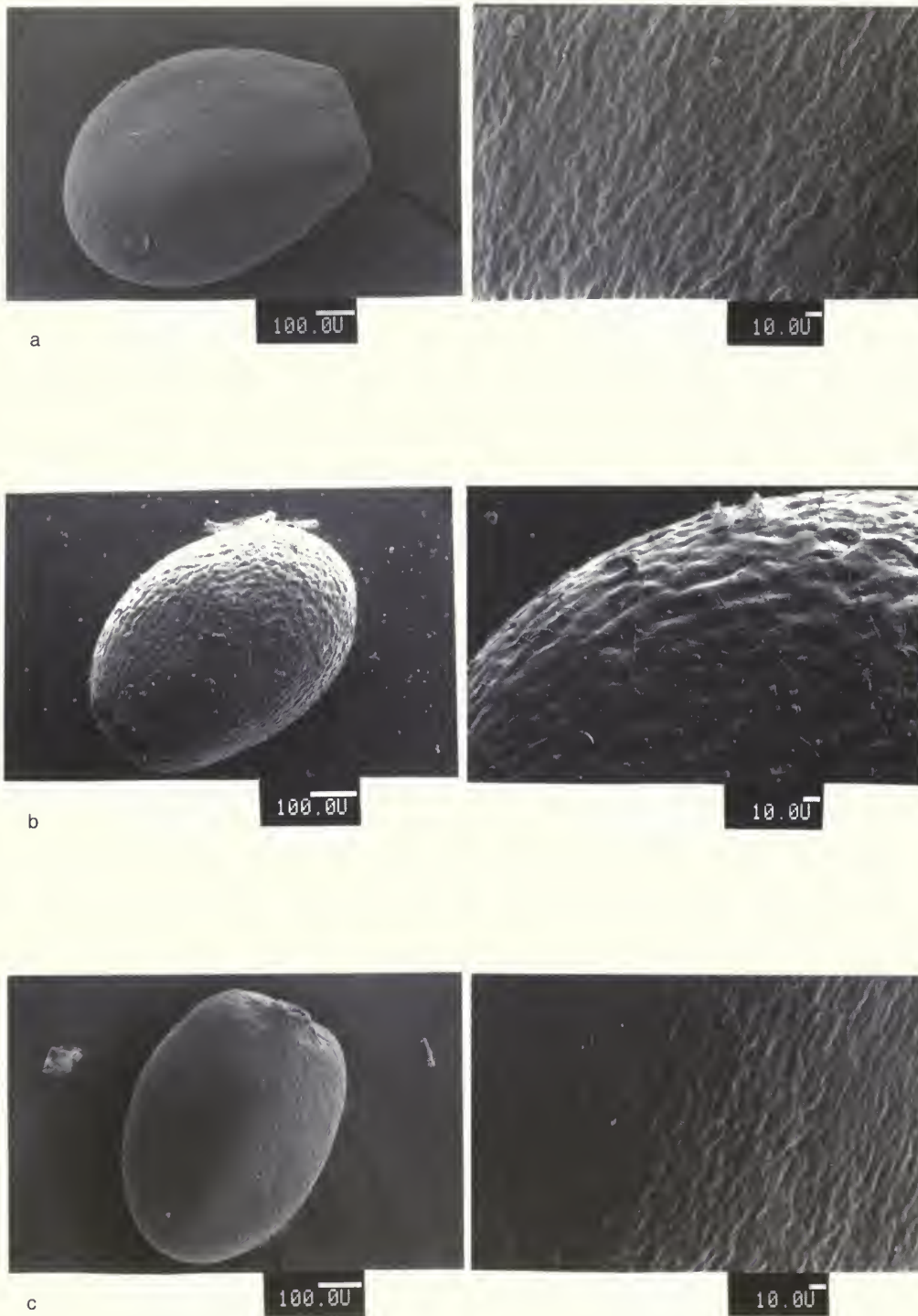


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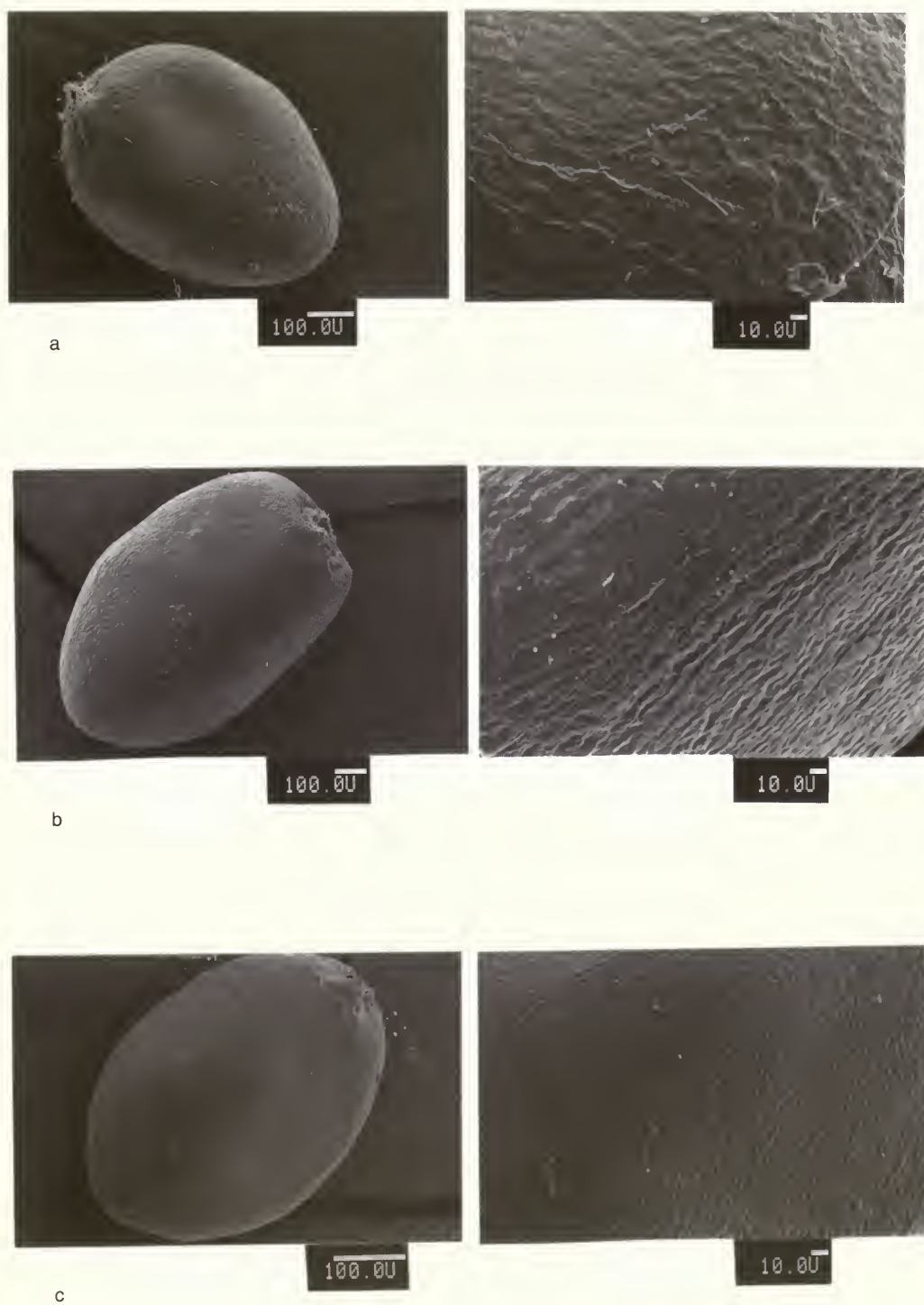
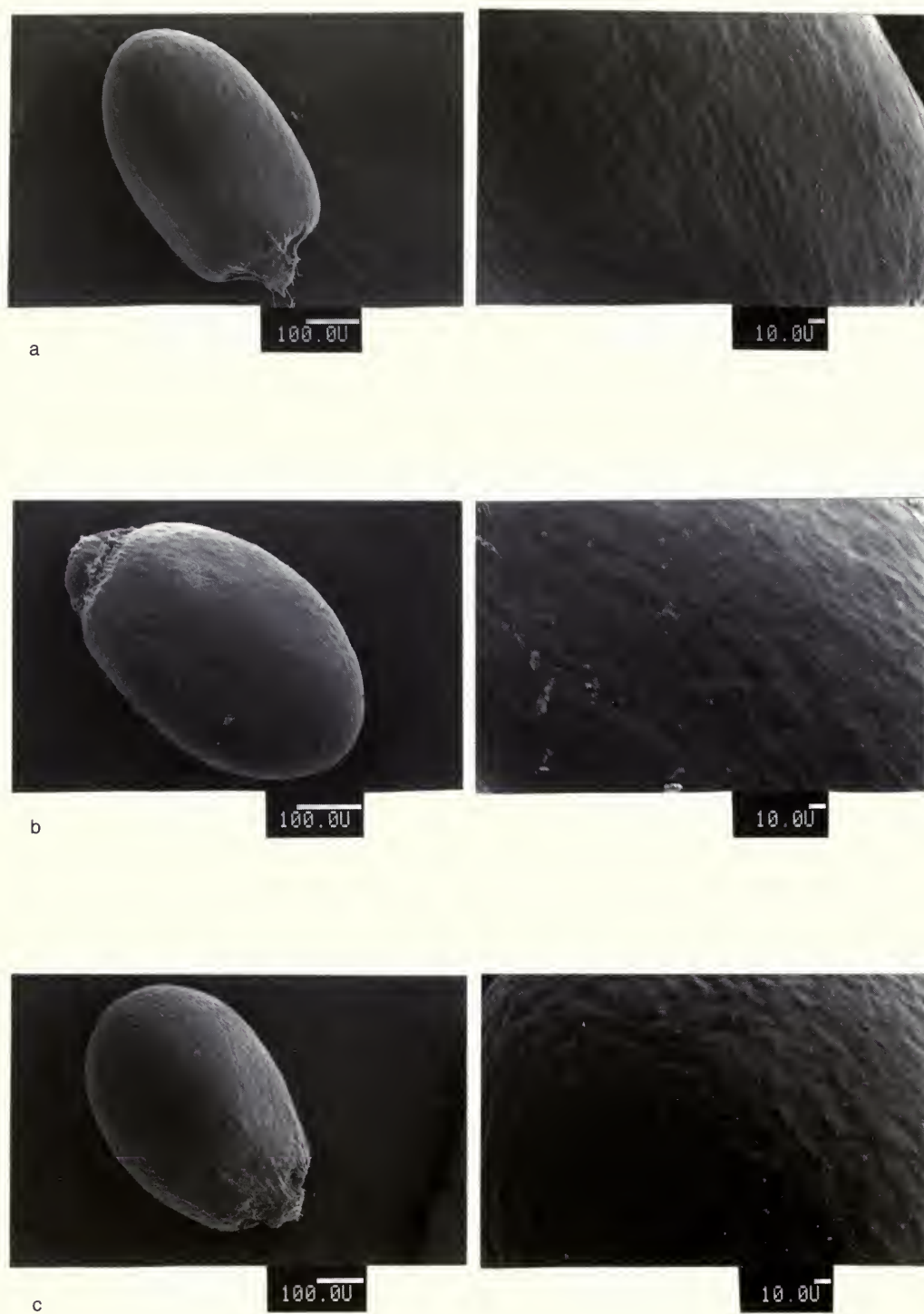
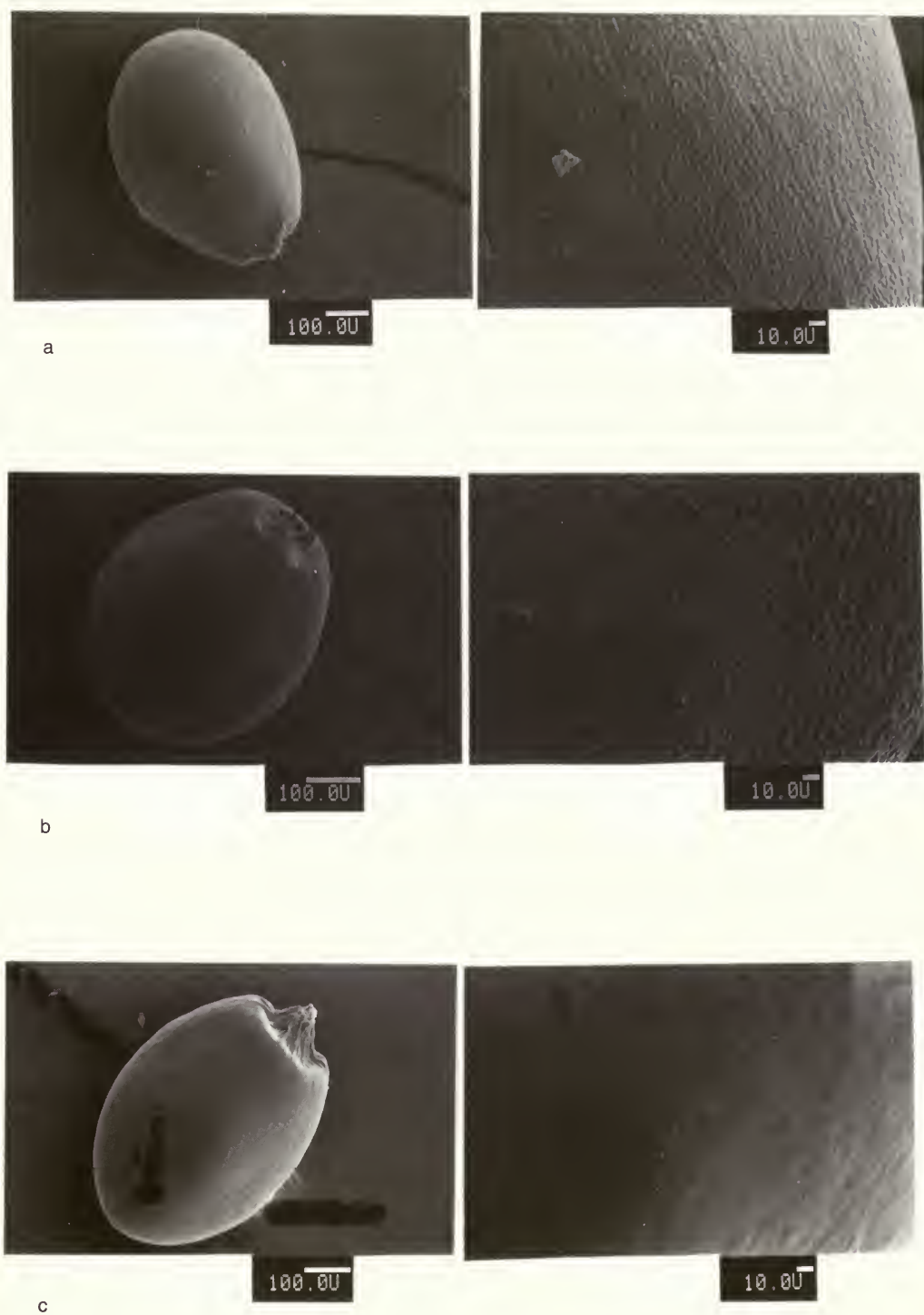


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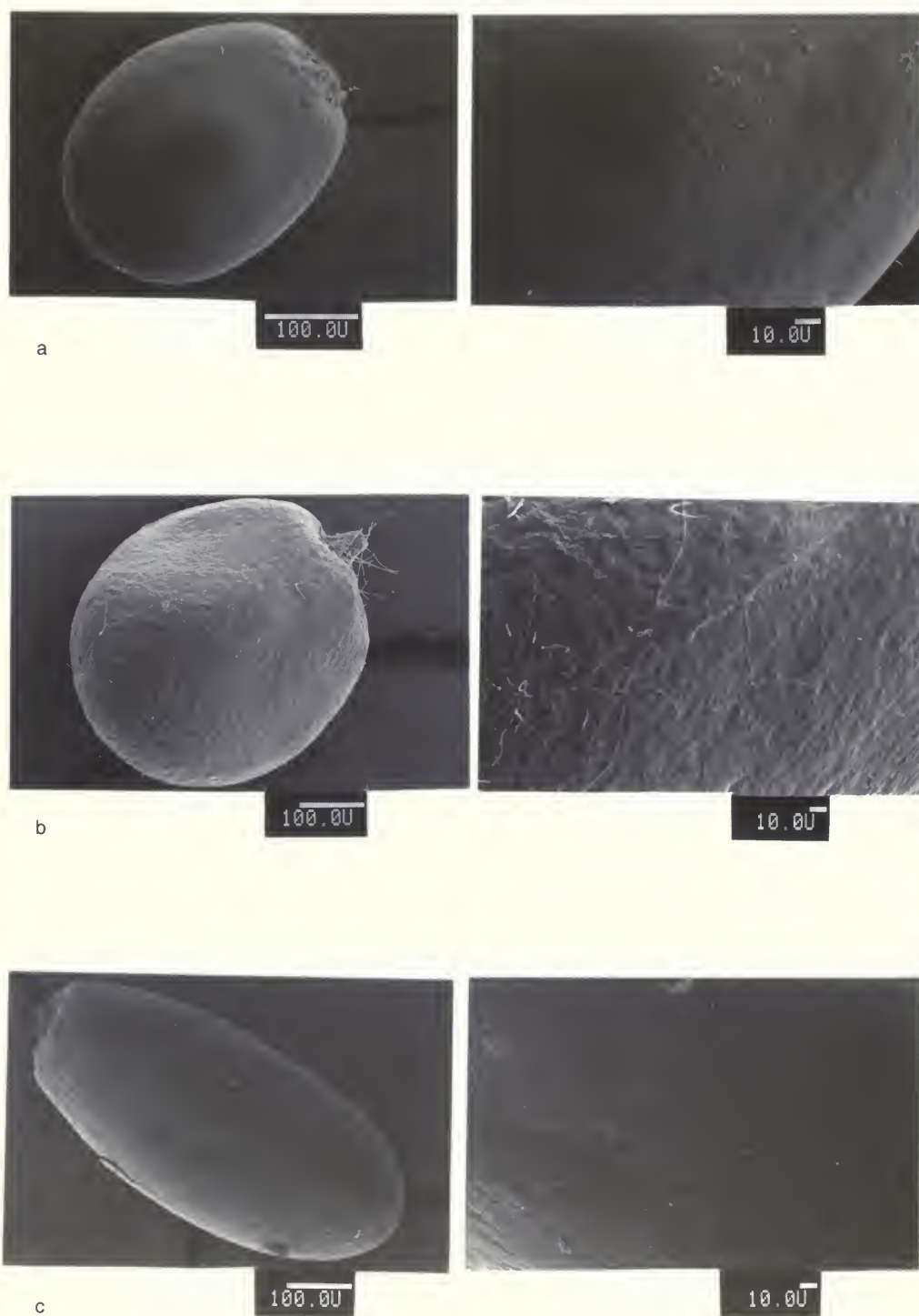


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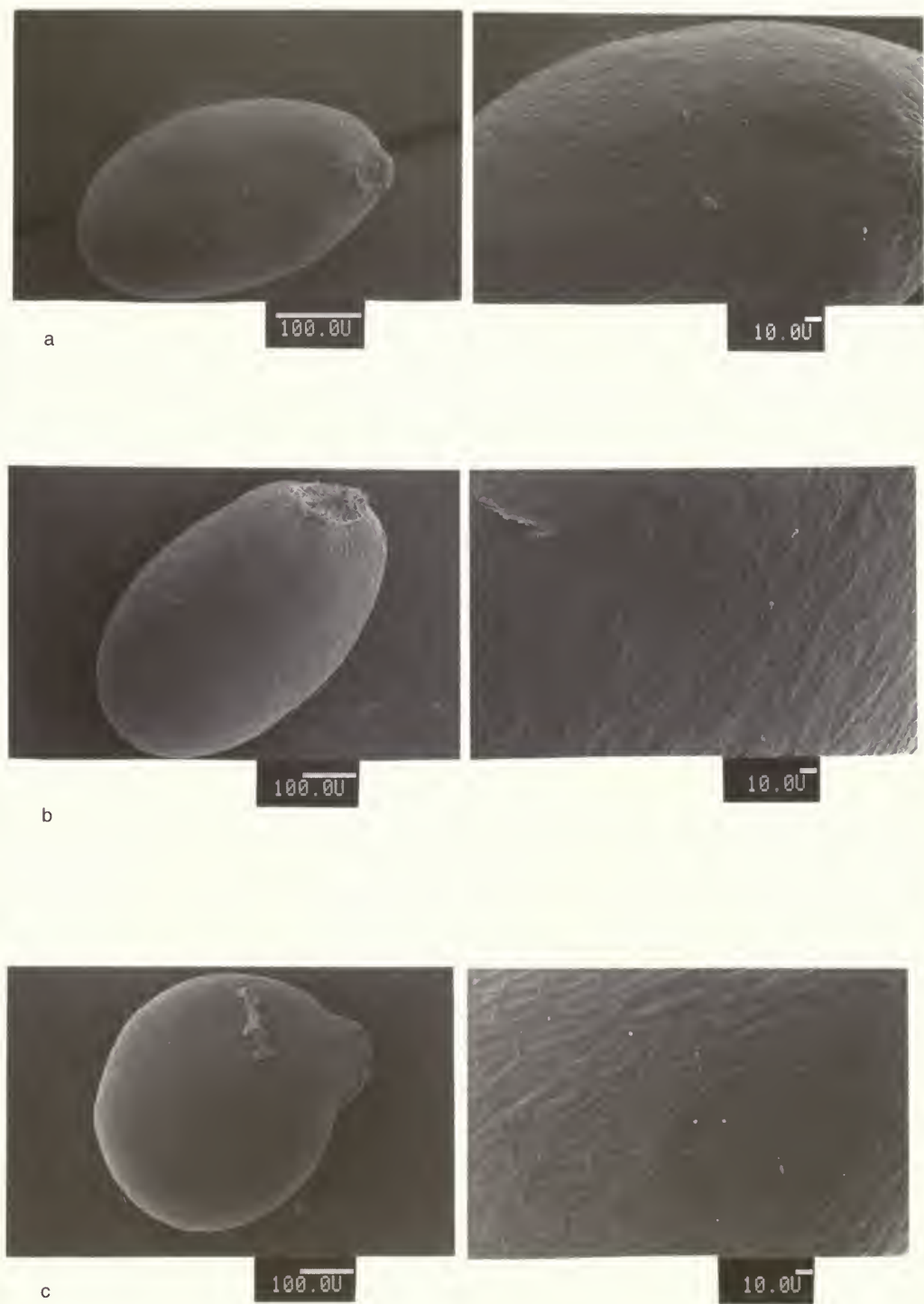


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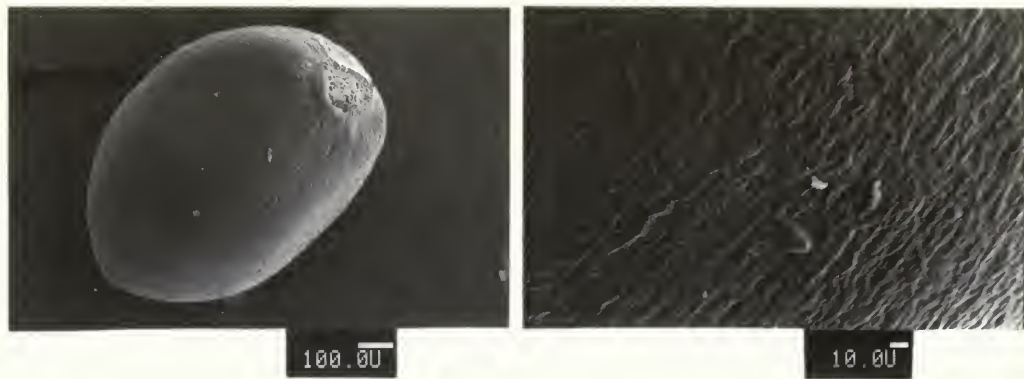


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